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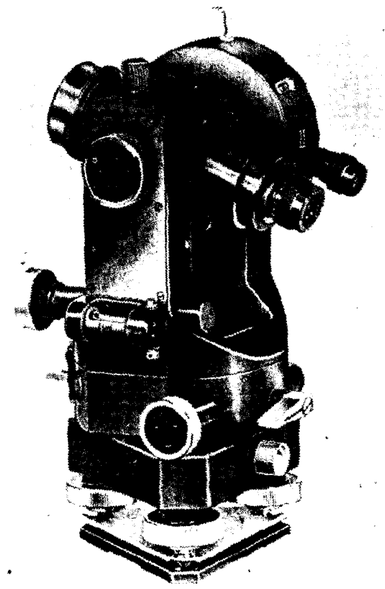
Display of Scientific Instruments by Veb Carl Zeiss Jena

IN 1908 the Zeiss-works in Jena gave a new incentive to surveying instrumentation and the further development of the art by taking up the production of surveying instruments. Light-weight construction, expediency, high measuring accuracy, and stability were the features which soon gained these new Zeiss products a world-wide reputation as top-quality instruments. In the pavilion of the German Democratic Republic at the II. Indian Industries Fair to be held from the 14th of November 1961 until the 1st of January 1962 in New Delhi, VEB Carl Zeiss JENA will show amongst other instruments of their extensive production programme the following surveying instruments which will certainly find the interest of the trade :

The Ten-minute Scale Theodolite "Theo 120" is mainly meant for measuring tasks where a standard error within the range from ± 15" to ± 20" of a direction measured in two telescope positions is permissible. Outstanding features of the appealing instrument are :

The x16 telescope which can be transitted both ways and which provides images marked for their brightness ; the graduated glass circles of high precision ; alignment collimators on either side of the telescope ; the high accuracy of the cylindrical axes ; the built-in optical plummet ; and the constancy of performance of the horizontal circle clamp. For surveying underground the "Theo 120" may be suspended on wall bars thus providing a highly efficient means to solve the difficult problems of the mine surveyor.

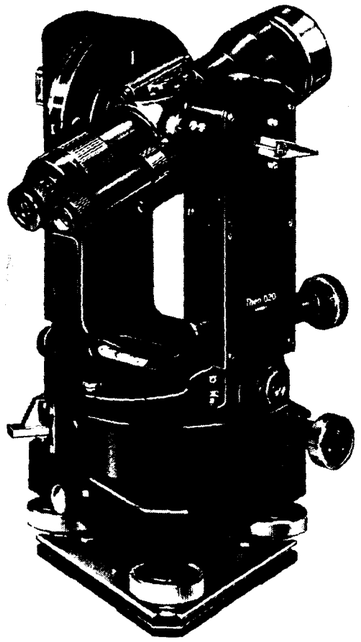
Surveyors will always look upon a theodolite of medium degree of accuracy as a standard instrument for angular measurements. For this reason VEB Carl Zeiss JENA put every stress upon the development of a new instrument of that class, the One-minute Scale Theodolite "Theo 020", notwithstanding the fact that its predecessor, the Tacheometer Theodolite "Theo 030", being represented in thousands the world over has successfully passed its numerous tests.



Tenminute-Scale Theodolite "Theo 120"

The developments in the "Theo 020" as compared with the "Theo 030" are :

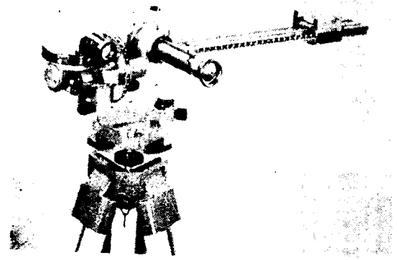
Owing to an enhanced precision of the graduated glass-circles the standard error of a direction measured in two telescope positions could be reduced to ± 3" to ± 4". The x25 telescope of high light-transmitting capacity may be transitted both ways. Automatic altitude index stabilization by means of an air-damped suspended pendulum. The telescope is equipped with collimating sights for either telescope position and the illumination of the scales is controlled by means of a knurled head. By incorporating an optical plummet in the alidade, centering over ground marks in two diametrally offset positions of the theodolite has been rendered



One-minute Scale Theodolite "Theo 020"

possible. If for some work only horizontal angles are to be measured, the reading scale for vertical angles can be covered.

There are quite a number of surveying problems which do not call for as high a degree of accuracy as they do for a rapid and convenient working method in first place. It is for such work that VEB Carl Zeiss JENA developed the Topographic Tacheometer " Teletop ". Its scope of applicability is rather wide and, in addition to topographic-tacheometrical measurements of lower accuracy, includes the measurement of distances, elevations and directions for geographical or geological detail as well as for land and forest valuation and engineering purposes. As the base lies within the instrument itself no measuring staff is required. For signalling purposes any kind of ranging rod will be satisfactory where the points to be sighted are not of particular prominence. Surveyings for the layout

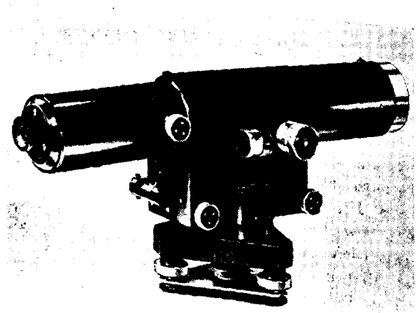


"Teletop"

of roads, railways and traverses as well as procuring data for aerophotogrammetrical work can be rapidly carried out with this instrument. Besides compass traverses for forest valuations the " Teletop " is available also for determining the height of trees and the diameter of tree trunks up to a diameter of 60 cm. The " Teletop " is a distance-measuring instrument with variable base which may either be used with support and tripod or with the support detached and a handle screwed in instead.

Distance errors are proportional to the distance and depend upon the prisms used. Errors in % of the distance range from ± 0.2 to 3%, distances from 2 to 600 m can be measured. Five prisms differing in their deflection angles overbridge the measuring range of the instrument whereby the individual ranges of the prisms are widely overlapping.

The Precision Level " Ni 004 " has been designed for levelling work of 1st and 2nd order and



Precision Level "Ni 004"

is specially recommended for: High-order levelling and point-inserting requirements, determination of fixed point elevations on ground sites and of water-mark posts in waterways, elevation measurements for geophysical purposes, observation of subsidence tracts in mining regions, precision elevation measurements in surface and underground constructional work, and for the installation and construction of large-type machines.

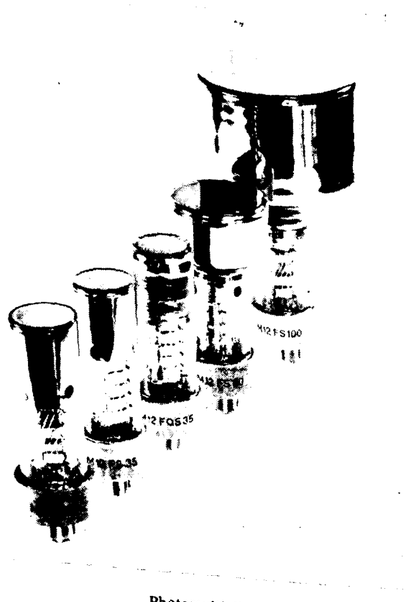
The mean error amounts to ± 0.4 mm for a one kilometer double-levelling operation, even under not particularly favourable conditions. The instrument is safely installed within a fully enclosed housing. The x44 telescope is equipped with a firmly built-in rocking plate micrometer, all manipulative elements are practically constructed and arranged. The cross spirit level, which has a sensitiveness of 2' per 2 mm travel is in a well-protected position at the housing and easily visible. Its centering is conveniently and accurately effected with the aid of the tribrach screws. Provided with a bearing free from play and friction the tilting system is of a very high degree of responsiveness so that even minutest inclinations of the telescope can be observed on the spirit level. The Precision Level is used in conjunction with special types of levelling staves of 3 m or 1.75 m length, the division of these staves being applied upon invar tape and the mean error of the staff-meter amounting to ± 0.01 mm.

Photoelectric Structural Components

The constantly growing number of fields of application made it necessary to develop a new series of photomultipliers, the " M 12 FS " models. Typical fields of such applications are: objective photometry (spectrometry, automatic exposure systems); measurement of rapidly occurring optical signals (image scanning in black/white and colour television, electro-optical distance measurement, phototelegraphy, measurement of shutter speeds, measurement of the decay-times of phosphors); and scintillation techniques (α-, β-, γ-, and neutron ray measurements, scintillation spectrometry, measurements in the 10^{-9} second range). These novel-type photomultipliers which likewise satisfy the demands made in optical and scintillation measuring techniques will be exhibited at the stand of VEB Carl Zeiss JENA in the pavilion of the German Democratic Republic at the II. Indian Industries Fair in New Delhi.

For photometric purposes the photomultiplier has essential advantages compared to photoelectric cells in those cases where, besides high quantum yield and a spectral range from 200 to 1300 mu, also short measuring times of 1 s to 10^{-8} s are to be attained and where the detection limit of the photoelectric effect as given by the thermal emission is to be fully exploited. These short measuring periods occur also in the above mentioned instances. With photoelectric cell and valve amplifier it is impossible to obtain the detection limit of the photoelectric effect and a short measuring period at the same time.

For the detection of radioactive radiation the superiority of the scintillation counter over the Geiger-Muller counting tube has been known for a long time. The scintillation counter gives a considerably higher yield for γ-rays than the G. M.-tube due to the greater density of the receiver (scintillator instead of gas fillings). For the detection of α-rays the scintillation counter has the advantage



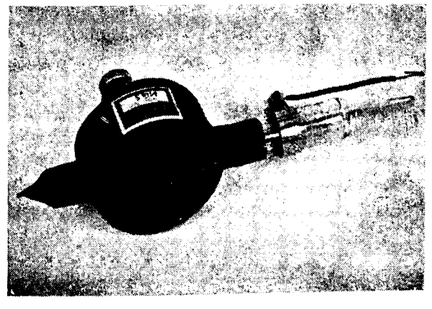
Photomultipliers

of not requiring an entrance window so that no energy of the α-radiation is lost between source and detector due to the absorption in the entrance window. The decisive advantage of the scintillation counter compared to the G. M.-counter consists however of the fact that with the scintillation counter not only the quantity of the radioactive radiation can be detected but, by means of β or γ scintillation spectrometry also the energy of the radiation and thus the type of radiating isotope. For all these reasons the scintillation counter has been increasingly used in isotope techniques. For all applications in isotope techniques a wide range of photomultipliers and scintillators has now been designed.

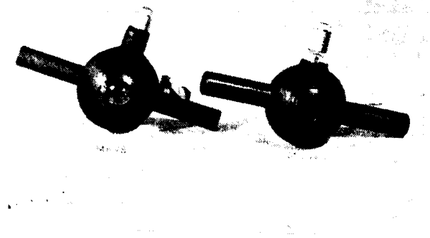
All photomultipliers have the same base and are designed so that they can be operated with the same voltages and therefore can be interchanged.

Due to its dimensions, the Multiplier M 12 FS 35 is especially suitable for portable instruments and apparatus requiring little space in photometry and scintillation measuring techniques. It is used for scanning systems (instruments for the local distribution of isotopes in the body) and this even when the scanning system works as spectrometer, i.e. where the distribution of certain isotopes in the body such as iodine, calcium, etc. are to be investigated. Its nuclear spectrometric properties seem to predestine the " M 12 FS 35 " for coincidence-scanning systems when position-emitting radio-isotopes are used, in which case a count is taken of the simultaneously emitted annihilation γ quanta, which are being emitted in the opposite direction.

The Multiplier M 12 FQS 35 has a quartz window and is intended for purposes where the emission



Measuring Photocells



Ball-shaped Measuring Cells

spectrum of the scintillator or the light to be detected is in the ultraviolet region. With otherwise identical operating data its sensitivity range is from 190 to 700 mu.

The Multiplier M 12 F 35 with its sensitivity maximum in the infrared region at 800 mu and with its sensitivity limit only at the long wave length of 1300 mu is specifically developed for photometric measurements.

The three photomultipliers " M 12 FS 35 ", " M 12 FQS 35 " and " M 12 F 35 " are also very suitable for photometric measurements. They have an electron-optical control system by which the effective area of the photocathode can be limited. In this manner thermal electrons can be masked from parts of the photocathode not utilised optically. This function was already described in detail.

Except for its cathode diameter the " M 12 FS 60 " has almost the same dimensions as the " M 12 FS 35 " and can therefore be used for similar purposes. It is however especially intended for apparatus on which the most exacting demands are placed with regard to nuclear spectrometric resolving power. Due to its very large photocathode, larger scintillators can be used and therefore even lower activities determined.

Because of their cathode diameters of 100 and 150 mm the " M 12 FS 100 " and " M 12 FS 150 " are employed where large surface or large volume scintillators are used. This is the case in the detection of α-radiation (α-monitors) and when using large diameter scintillators or large compact scintillators, which are advantageous because of their low Compton proportion. Typical applications for the

" M 12 FS 100 " are instruments for the detection of total radiation incorporated in the body (human counter). Also here the high nuclear spectrometric resolving power is of interest, as this property is necessary for determining which type of isotopes are incorporated in the body.

Intensification of faint images and radiation transformation from the non-visible into the visible region of the spectrum is nowadays effected with the help of so-called Image Converters. ZEISS-JENA made Image Converters " BW 55 ", " BW 55 S ", and " BW 35 QS " are of the electrostatic type.

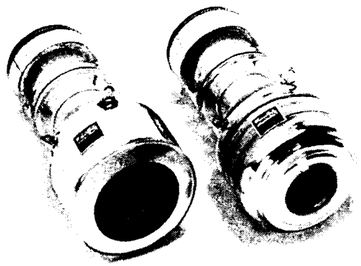
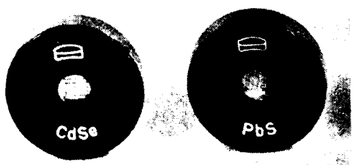
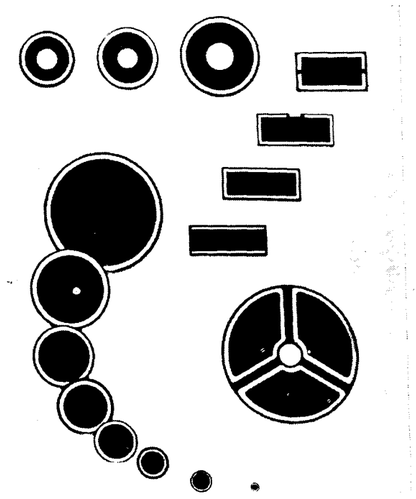


Image Converters



Photoresistance Cells



Photovoltaic Cells

The " BW 55 " has a caesium-oxide cathode and is used for image transformations from the infrared spectral region. The " BW 55 S " is mainly employed as image intensifier whereas the " BW 35 QS " serves for image transformations from the ultra-violet into the visible region.

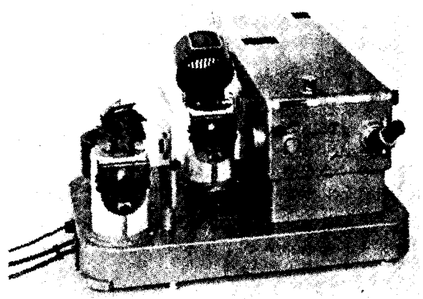
Photoresistance cells have a wide sphere of application, in photoelectric controlling and regulating functions the ZEISS CdSeG-types have given excellent results. Their small dimensions and high current-yield make them particularly suited for industrial purposes. To the same ends the PbS-type photo-resistances are used the spectral sensitivity of which lies in the near infrared region up to 3.5 u. For temperature measurements this type can be supplied with increased sensitivity by cooling the PbS film.

In enterprises engaged with the production or creation of exposuremeters photovoltaic cells are regarded the most essential structural units. A fair selection of their range in these photoelectric radiation detectors is also shown by VEB Carl Zeiss JENA at their stand in New Delhi.

Opto-physical Measuring Instruments

In the pavilion of the German Democratic Republic at the II Indian Industries Fair to be held from the 14th of November 1961 until the 1st of January 1962, VEB Carl Zeiss JENA is going to show amongst other products of their extensive production programme the following opto-physical measuring instruments which deserve special mention.

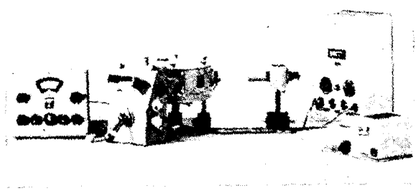
The Industrial Spectroscope, an instrument of outstanding optical and mechanical efficiency, has been designed in a way which permits its application in the various fields of industrial material testing, primarily for rapid spectrochemical analyses for all kinds of metals. It should be used where numerous metal specimens are to be routine tested qualitatively and quantitatively for their composition and where the spectrochemical methods depending on plates are too time wasting, but where on the other hand the electronic, direct-reading methods require excessive investment in apparatus and personnel. The principal field of application for the Industrial Spectroscope is therefore in the small and medium-sized industrial and research inspection laboratories, e.g. in metal and semi-finished product stores, in annealing and tempering plants, in scrap yards and scrap re-claiming depots, foundry laboratories, metallurgical, metallographic and mining experimental stations and similar inspection points where the speedy recognition of the material quality is frequently of great economic importance. With suitable preparation of powdered specimens or of solutions pressed in the shape of pellets or by means of auxiliary carbon electrodes, it will be possible to extend rapid visual analysis with the Industrial Spectroscope to non-metallic materials.



Industrial Spectroscope

The optical performance of the Industrial Spectroscope with photometric device becomes obvious by the following technical data : high dispersion by two double-effective flint-glass prisms, D = 0.9 Å /mm at 5000 Å ; the resolving power $\lambda/\Delta\lambda = 17000$ at 5000 Å means that 0.3 Å can still be discerned ; large aperture ratio of 1 : 11 ; two different magnifications ; x8 for low-power viewing and x22 for exacting observations ; direct wavelength determination to ± 2 Å ; the coarse motion ensures a rapid survey of the spectrum—precise setting with the aid of the fine motion : isochromatic photometric evaluation with a neutral wedge of high pitch, thus no loss in light-intensity by polarising filters ; convenient reading of wavelengths and extinction on frosted screens ; two attached spark stages within easy reach from the operator's place ; rapid change of the counter-electrodes ; self-contained rigid design.

The Universal Spectrophotometer " VSU 1 " is a non-recording singlebeam instrument based on electrical compensation without amplification. Test specimens are compared with respective reference specimens (reference value). The actual measurement is effected by compensating the voltage drops which, caused by the unvaried and varied beams of light, occur at a high-ohmic resistor. The ratio of the compensation voltages converted into transmission or extinction values can be directly read.



Universal Spectrophotometer

A light-source illuminates the entrance slit of a monochromator in front of the exit slit of which a cell-changing device housing three cells is assembled. The current supplied by the photoelectric cell brings about a voltage drop at a high-ohmic resistor which is equalized with the help of a compensator unit, using a unifilar electrometer as zero instrument. The

operating voltage comes from the a. c. mains supply via a voltage stabilizer.

The interchangeability of radiation detectors and dispersion prisms—a salient feature of the instrument—permits of using the Universal Spectrophotometer "VSU 1" in the spectral range from 205 to 2700 m μ.

ZEISS-JENA Precision Structural Units for Automatic Control and Regulating Systems

Industrial automatic control and regulating projects create an ever growing demand for structural components with which to proceed in the automation of plants and machines. VEB Carl Zeiss JENA produce a full range of sub-assembly units for remote control and computing facilities using potentiometers. At the ZEISS-stand in the pavilion of the German Democratic Republic at the II. Indian Industries Fair to be held from the 14th of November 1961 until the 1st of January 1962 in New Delhi these structural units will undoubtedly find the interest of the trade.

Transmitter Potentiometers are made available in three sizes, viz. Gepo 40, Gepo 63, and Gepo 100 (Fig. 1). In class 1 the linearity guaranteed by the most advanced technological and testing methods is smaller than ± 0.1 %. Even when turning with a speed of 360°/s the transition resistance is very low. Mechanical stops limit the turning range to 330° ± 2°. All potentiometers can be supplied with resistance values between 100 and 10,000 ~. For use under rough conditions or in aggressive atmospheres the precision potentiometers Gepo 40 are furnished with a robust cast-iron casing and listed as "Gepo 40 Pz" (Fig. 2). Special mention should be made of the long life of the precision potentiometers as confirmed by extensive endurance tests. It needed a slide of the contact arm of six km

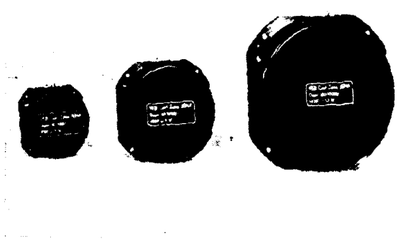


Fig. 1. Precision Potentiometer "Gepo"

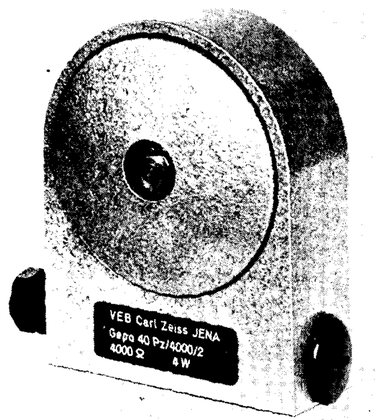


Fig. 2. Precision Potentiometer in cast-iron casing "Gepo 40 Pz"

length, i. e., a number of approx. 25 million operations to wear the contact arm down. After replacing the arms the potentiometers could be fully used again providing an unvarying linearity.

In many provinces of remote control techniques full rotations in both directions have to be transferred in addition to limited angular movements. So-called four-wire transmissions for the remote control of unlimited angular values can be carried out with the Infinite Potentiometer Upo 63 (Fig. 3). This type is with closed ring winding and four tappings staggered at 90°. Two pickoffs, insulated from each other and staggered by 180°, are supplied via slip rings and slide along the resistor track. Infinite potentiometers require a torque of 20 cmg and are normally used in pairs, with the transmission accuracy

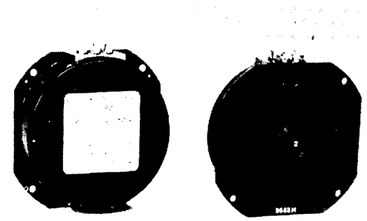


Fig. 3. Infinite Potentiometer "Upo 63"

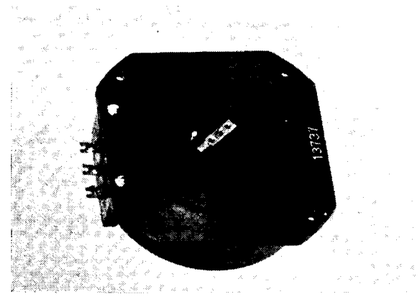


Fig. 4. Precision Instrument Potentiometer "Ipo 40"

of transmitter and receiver potentiometer being better than ± 0.75°.

ZEISS-JENA Precision Instrument Potentiometers (Fig. 4) are particularly meant for transmitting angular values from instruments giving only low adjusting forces. Same as the ordinary potentiometer types the Instrument Potentiometers "Ipo 40" are available in three linearity ranges, those of class 1 having a linearity of better than 0.1%. The required torque is as small as 1 cmg; the "Ipo 40" pots are made with resistance windings ranging from 200 to 2500 ~.

Small starting and stopping delays, low moment of inertia, and a favourable ratio between transferable torque and power consumption are the salient features of the ZEISS Magnetic Couplings (Fig. 5). The mechanical performance transferred by the Magnetic Couplings is a multiple of the required electrical control output. These outstanding characteristics are the result of production methods placing the highest demands on the truth of all moving parts.

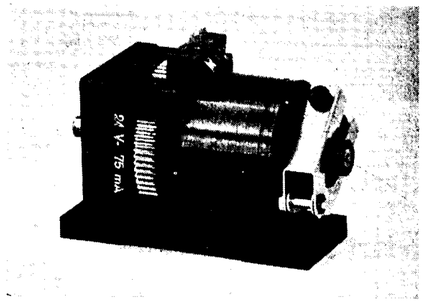


Fig. 5. Magnetic Coupling "Maku"

By means of the Magnetic Couplings "Maku 400" and "1200" torques of 400 and 1200 cmg, resp., are transferred. Time delays until reaching the full number of revolutions amount to approximately 20 milliseconds (ms), whereas 15 ms can be stated as stopping delay. As maximum number of motive revolutions 1500 rpm are permissible. Thus, a mechanical performance of approximately 1.85 mkg/s, which corresponds to an electrical output of about 18 watts, is transferable by a "Maku 1200". The electrical control output required is 2 watts.

Arranging two "Makus" on a plate and coupling their driving shafts by gears brought the Reversible Magnetic Couplings "Relag 400" and "Relag 1200" (Fig. 6) into existence. All technical data are the same as of the "Maku" types. "Relags" are used to advantage as regulating links in servo circuits and in tele-transmission functions. Within a few milliseconds a "Relag" changes the sense of rotation at the regulating spot of a servo circuit or an

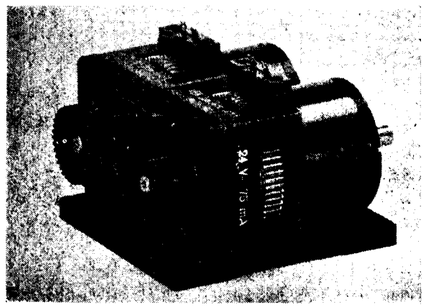


Fig. 6. Reversible Magnetic Coupling "Relag"

operative line. Of great importance for the realization of many an automation project are the small moment of inertia of the rotating parts and the advantageous ratio of the required control output to the mechanically transferable performance.

ZEISS Trimming Resistors "Juwi 25" (Fig. 7) are indispensable aids for the trimming of bridge connections. They are particularly helpful wherever a resistance value determined by adjustment has to be kept constant over a longer period of time. Having a sturdy design and offering the possibility to slip them on to a mandrel, the Trimming Resistors afford space-saving arrangements. The "Juwi 25" is available with the three different resistance values of 100, 325, and 1000 ohms.

Precision structural units made by VEB Carl Zeiss JENA are the fundamental components of an assembly unit system for remote control functions and computing facilities based on the principle of the self-balancing Wheatstones-bridge In literature the manifold applications of such structural units are dealt with at length. Outstanding advantages of the ZEISS-JENA structural units are their high constancy of performance and their long service-life as ascertained by extensive endurance tests.

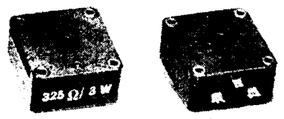


Fig. 7. Trimming Resistor "Juwi 25"

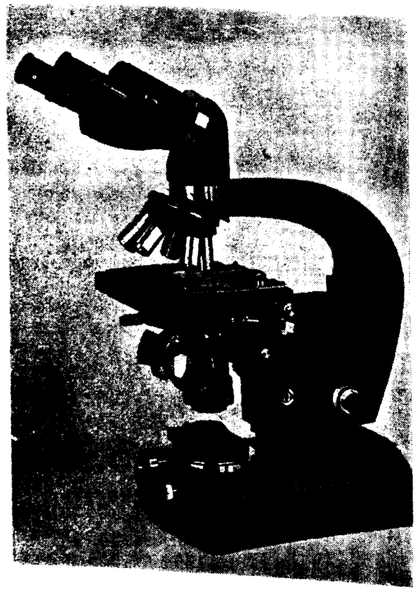
ZEISS-Microscopes

Amongst other technico-scientific instruments VEB Carl Zeiss JENA will also have microscopes on show at their stand in the hall of the German Democratic Republic at the II Indian Industries Fair to be held in New Delhi from the 14th of November 1961 until the 1st of January 1962.

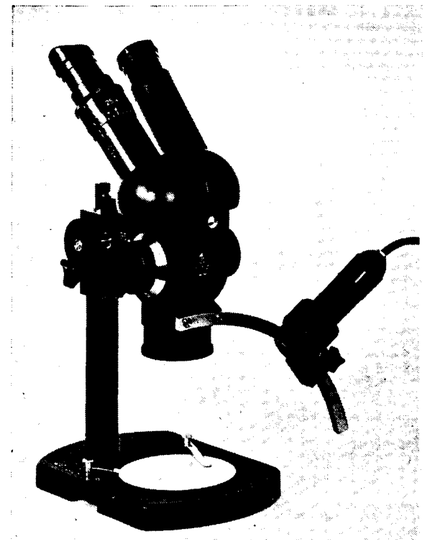
Microscopes are the classical ZEISS-instruments, their manufacture was taken up as early as 115 years ago in the then small workshop of Carl Zeiss in Jena and since 90 years their design is based on the scientific principles found by Prof Dr. ERNST ABBE. Ever since ZEISS-microscopes have renewed their world-wide reputation. Amongst the microscopes exhibited in New Delhi the following models deserve special mention :

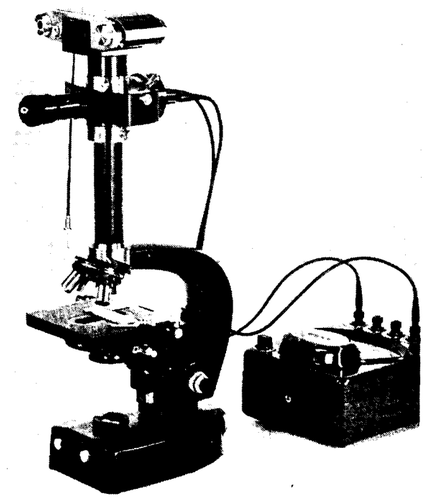
The microscope "Ng" is specifically adapted for all routine examinations in transmitted light. Retaining the efficient form of tube-carrier of the "L" stands it embodies the following out-standing improvements :

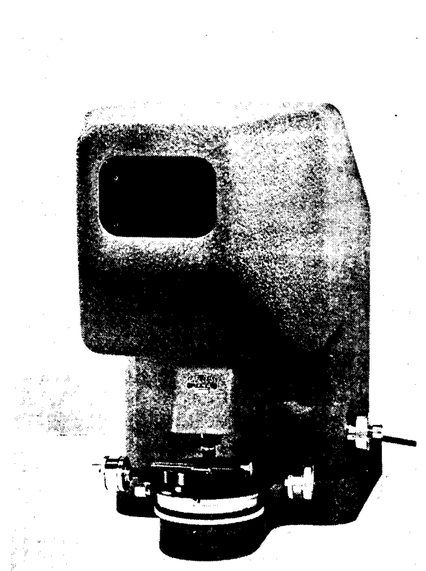
a new tube-assembly provides the factor 1 for both monocular and binocular observations, the object-stages can be easily interchanged by virtue of a quick-changing device, co-axial coarse- and fine-motion

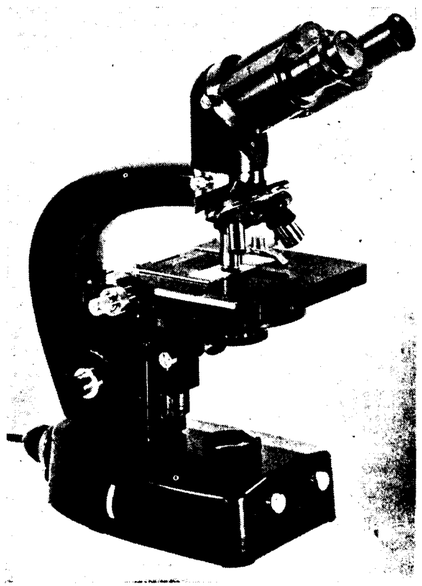


Microscope Nfpk 2









Zeiss range of Microscopes

controls, the fine-motion slide runs on ball bearings, condenser supports including the phase-condenser are detachable, the sliding sleeve for condensers has been replaced by a quick-changing device, the lamp as also the screw-adjustable deflecting mirror are installed in the base. For specific kinds of work the microscope may be used in conjunction with another illuminant, such as the luminescence lamp, for instance.

The " Nf " Research Microscope represents a constructional advancement of the well-known " L " microscopes for examinations in transmitted and incident light. For work in transmitted light it is equipped with built-in illumination and is in its standard equipment supplied with the known triple-turret pancratic condenser.

For specific outfits same may be replaced by individual condensers with interchangeable supports. The same innovations already referred to in connection with the " Ng " microscope also apply for the " Nf " model which furthermore affords the following advantages: attachable pancratic system with condenser turret, annular stop for variable phase-contrast work in conjunction with the pancratic system, quintuple objective turret for Achromats, Plane-field Achromats or Apochromats.

The " Nf " may be converted into an incident-light microscope by simply detaching the condenser motion box, lowering the stage-carrier and by attaching the incident-light condenser in place of the objective-turret.

For clients intending to work exclusively with incident light, a special " Nf " outfit is provided for (" Nf " for incident-light only) where the base with built-in illuminant is replaced by an ordinary flat horse-shoe base.

The Stereomicroscope " SMXX " has the following advantages to offer for all kinds of stereomicroscopic dissecting work: rapid change of magnification within the range from x4 to x100; large, invariable working distance of 100 mm.; large, flat fields of view up to 44 mm. diameter; the inclined binocular tube can be mounted as desired in two observation directions, differing by 180°; pronounced stereoscopic effect. By a number of supplementary devices the instrument may be adapted to various specific purposes: handrests, ball stage, bage for transmitted light, device for examining unmounted jewel bearings, a multi-purpose stand and a photomicrographic equipment.

The Photomicrographic Equipment " MF " can be used in conjunction with all ZEISS-microscopes and, in a special outfit, also with stands of other makes. As camera one may either use the conventional types of 35 mm cameras, the camera attachment 24 × 36, or the camera attachment 6 × 6 cm. The focusing telescope affords both reliable focusing and observation of the object during exposure. Low-power photomicrographs are taken with " M " objectives. A device for measuring the exposure is a valuable supplement.

On the ground-glass screen of the Projection Microscope " Lanameter " all microscopic objects can be observed and measured. Particular applications are the inspection of fibres such as wool, cotton, silk, man-made fabrics, etc. Image scales on the screen are: 150 : 1, 200 : 1, 250 : 1, 500 : 1 and 1000 : 1. A special object traverser for systematic exploring of the specimens by virtue of its adjustable stops affords prevention of duplication of measurements and, in addition, the setting of measuring spots according to acoustic impressions. An attachable light-screening hood permits working in rooms that are not darkened.

The " Epignost " has been designed for the rapid examination of ground, polished, or natural surfaces of objects. It affords every convenience of operation and a range of magnifications from x52 to x285. Observations can be carried out in bright-or dark-field and with polarised light. In bright field a plane-glass or a prism may be optionally used. The optical outfit comprises an Apochromat, plane-field objectives and new specially computed eyepieces providing practically flattened fields of view. The monocular inclined tube with quick-change device can be replaced by a binocular tube and be turned into any direction of observation. The light-source has a 6V 15W filament bulb and is firmly built-in. The " Epignost " outfit can be completed by various supplementary devices such as a translumination base, the " MF " photomicrographic equipment, etc.

New Components for Vacuum Techniques

High-vacuum techniques have become an integral part of modern technology and, though originally confined to physics, are now finding application in all provinces of industry.

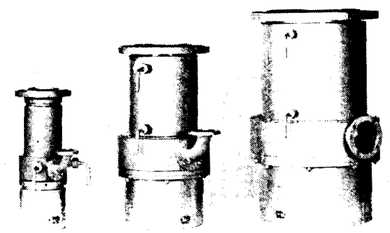
Despite of their differing scopes of application all high-vacuum evacuating plants have certain characteristics in common. All of them consist of a pre-vacuum generator, a high-vacuum generator, valves, pipe-connections, and vacuum-chambers. Depending on their practical purpose vacuum-chambers may be designed to function as ovens, evaporating jars or rakes, whereas pre-vacuum and high-vacuum generators, valves, and pipe-connections are universally applicable.

High-vaccum generators and valves are the very components bearing the greatest consequence for the proper functioning of the evacuating plant and, thus, for the realization of the high-vacuum working process. These considerations prompted VEB Carl Zeiss JENA to develop high-vacuum aggregates which are equally well suited for both research and industrial production. In the pavilion of the German Democratic Republic at the II Indian Industries Fair to be held from the 14th of November 1961 until the 1st of January 1962 in New Delhi, VEB Carl Zeiss JENA are going to exhibit these components inviting the opinion of the experts.

Further to the already widely-used and approved " High-vacuum Unit 120 ", comprising the three-stage high-vacuum oil diffusion pump " HVPO 120 " with oil-vapour baffle, high-vacuum valve, pre-vacuum valve for high-vacuum chamber, pre-vacuum valve for high-vacuum generator, air-inlet valve with dust filter, containers and connection possibilities, new high-vacuum oil diffusion pumps and valves have been shown in public at the last Leipzig Technical Fair which are also included in the ZEISS-exhibits at New Delhi.

For higher suction speeds two furher oil-diffusion pumps with the respective baffles were developed which are based on the principle adhered to so far. They are listed as " HVPO-500 " (Fig. 1) " HVPO-2000 " and afford suction speeds of 500 L/sec. and 2000 L/sec., resp., at an intake pressure of 10^{-4} Torr.

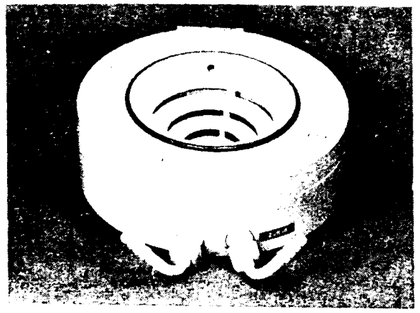
Both " HVPO-500 " and " HVPO-2000 " are water cooled and of the threestage type. As propellants special high-vacuum oils with a low vapour pressure ($< 10^{-8}$ Torr at 20°C) are used. Same as in the case of the " HVPO-120 " the principle of good fractionation, degassing of the oil, and propellant-sparing heating has been adhered to. A special design of the nozzle assembly permits of heating at the periphery of the boiling vessel. As compared with the convential types of nozzle assemblies, ZEISS-JENA arranged the boiling chambers of the individual stages one above the other instead of placing them side-by-side in one common plane. Thus, each stage receives its oil vapour from a separate chamber assigned to it. First the propellant has to pass through the boiling dishes of the first and second stage until it reaches the boiling chamber of the high-vacuum stage. This compulsory long path to the third stage frees the propellant from most constituents having low and medium-high boiling points. Good oil fractionation, de-gassing and self-purification of the propellant are thus accomplished in the shortest possible time. A particular proportioning of the heating system renders high suction speeds in the high-pressure range possible and keeps the reflux into the high-vacuum chamber very low.



High-vacuum Oil Diffusion Pumps
"HVPO-2000", "120", "500"

For rapid oil changes the lower section with the nozzle assembly can be separated from the upper section—same as with the " HVPO 120 "—without dismantling the upper part from the high-vacuum plant being necessary.

If a high-vacuum is demanded particularly devoid of oil vapours, the above mentioned low vapour reflux



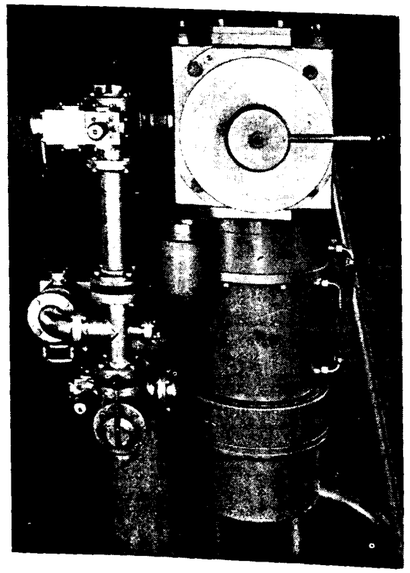
High-vacuum Oil Vapour Baffle "DSO-150 w"

into the high-vacuum chamber may still be decreased by incorporating the newly-developed Oil Vapour Baffle " DSO-150 W " in the vacuum-line (Fig. 3) when working with the " HVPO-500 " or the " DSO-250 W " when using the " HVPO-2000 ". The oil vapour baffles are water cooled and reduce the vapour reflux into the high-vacuum chamber by the factor 10^4.

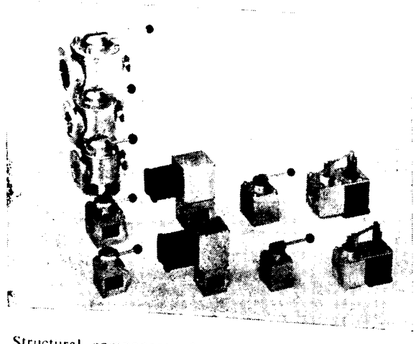
Application of the new high-vacuum oil diffusion pumps will be manifold. They are specially suited for : vapour-depositing plants in precision mechanics and optics; physics ; semi-conductor techniques ; electrotechnics ; founding-, smelting-, annealing-, and sintering plants in metallurgy ; de-gassing—and impregnating plants in electrotechnics ; low-temperature drying plants and evacuating units in the chemical and pharmaceutical industry and in medical techniques ; electron-and ion-optical instruments ; accelerators and mass-spectrometers in nucleonics and nuclear physics.

In completion of the ZEISS-range of instruments and structural units for vacuum techniques the following new valves have been made available :

Additionally to the Magnetic Backing Pump Valve with Retarding Relay " VVmA 20 " the " VVmA 32 " has been created for the same purpose but with standard width 32. This combination of shut-off and air-inlet valve is suited for backing pumps with suction speeds from 10 to 20 m^3/h, as required, for instance, by the ZEISS Oil Diffusion Pump " HVPO-500 " in normal use. After closing the vacuum line leading to the high-vacuum part this valve provides an air-inlet to the rotary backing pump thus preventing any possible rising of the oil

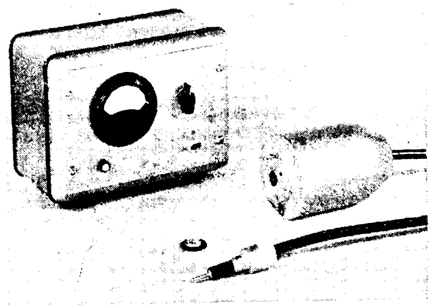


High-vacuum Unit "HVAO 6/2000/1"

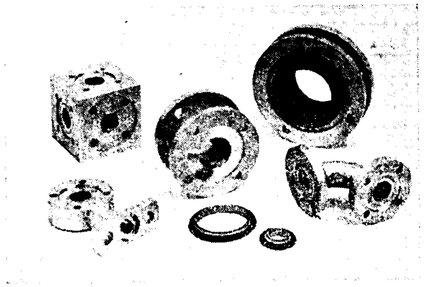


Structural components for high-vacuum techniques : shut-off valves, magnetic shut-off valves, backing pump valves, magnetic backing pump valves

from the backing pump. In the case of current failure the valve automatically shuts off obviating a detrimental air penetration. Appropriate valve lift and short conduction guarantee minutest losses by flow. Only the backing pump is switched in or off, switching of the magnetic backing pump valve is



High-vacuum Measuring Instrument "HVM-6/B"



Structural components for high-vacuum techniques : cross, intermediate fitting, ring support, etc.

effected automatically at the proper time by the retarding relay. Faulty manipulations are thus precluded.

The Backing Pump Valves " VV 20 " and" VV 32 " are also novelties and likewise combinations of shut-off and air-inlet valves. Throwing a lever shuts the suction line off and simultaneously provides an air-inlet to the backing-pump, These types have been designed for laboratory use in order to replace the currently used glass taps, the small cross sections of which considerably reduce the suction speed already at the backing pump.

With high suction speeds needle valves are needed for gas currents higher than 20 Torr L/sec. ZEISS-JENA manufacture the following models : Needle Valves " NV 20 ", " NV 200 ", and " NV 2000 ". Gas currents are regulable from 0 to 20 Torr L/sec., 200 Torr L/sec., and 2000 Torr L/sec. All needle valves have the same housing and differ only in diameter and seat of the needle. The needle and its seat can be exchanged. When the valve is closed a fixed stop impedes any further movement in closing direction and, thus, an in-appropriate stress on the needle. Due to their precision design and micrometer movements these needle valves permit of attaining repeatable gas currents to be let into evacuated spaces.

Two further novelties are on show in New Delhi : the Shut-off Valve " EV 20 " and the Air-inlet Valve " FV 20/5 ". Being of simple design, the Shut-off Valve " EV 20 " (20 = standard width of the connection) affords a rapid and reliable shutting by throwing the lever. In contrast with spindle valves the switch position can be recognized at once, which is very important with vacuum lines and helps to diminish the number of possible faulty manipulations. The " EV 20 " is tight under backpressure, i. e., the atmosphere pressure can act on the valve lid adversely to the direction of closing without causing any leakiness. High-vacuum chambers may be aerated with the help of the Air-inlet Valve " FV 20/5 ". Its flange has the standard width 20, the free aperture is 5 mm. Air is sucked in through a filter which has little effect on the flow-in speed but adsorbs foreign bodies.

Building Blocks from Fuel Ash

Pulverised fuel ash—the waste product left over after burning fuel in power stations—is being used as building material in two 14-storey blocks of flats nearing completion in London. It is believed that this is the first time this hitherto almost useless by-product has been used on buildings of this size.

The fuel ash has been made into hollow blocks to make wall panels against which supporting reinforced structure was cast. The blocks are fireproof, are lighter, and claimed to have better thermal insulation than the ordinary brick. The exterior cladding has been made of a " skin " of normal brickwork placed in front of pulverised fuel ash walls as the latter should not be exposed to weather.

The Application of Levelling Agents for the Dyeing of Textiles

It is the aim of every dyer to produce well coloured material and to achieve its uniform, i. e. level appearance. This article intends to acquaint the dyers briefly with various types of levelling agents and their suitable application, even though, in some cases, level dyeing can be achieved also by the accurate control of temperature, by pH, by additions of salts or acids and by certain dyeing time limits.

The principle of level dyeing is to achieve a certain equilibrium between the amount of dyestuff attached to the fibre and the amount still in the dye-bath, i. e. to effect a control of the rate of attaching of the dye to the fibre. The result depends partly on the behaviour of the fibres towards the dyestuff (protein fibres behave differently as compared with the cellulose ones), partly on the levelling properties of the dyestuff proper. The choice of levelling agents must therefore be made according to these two mentioned points of view.

Common practice shows that badly levelling dyes have better wet fastness than the well levelling ones and that the better levelling is obtained the slower is the attaching of the dyestuff to the fibre and the weaker is its affinity to the fibres. An important part is also played by the dispersion of the dyestuff, i. e. by the size of its particles and by their mobility.

In the case of standard badly levelling acid dyes for wool, conditions can be improved by the addition of acetic or formic acid, by a neutral initial dyeing followed with gradual additions of the acid, by low initial temperature or by means of levelling agents. Namely if the dye-bath contains high-molecular anions of the levelling agents, a competition takes place which results in a more rapid attaching to the fibre of the sulphatized fatty alcohol-type levelling agent, or of a suitable wetting agent (for example, Syntapon L, Neokal pr.), as compared with the attaching of the dyestuff. A part of the material is thus engaged with the levelling agent and the dyestuff must therefore migrate into the interior of the fibres, or it must force away the levelling agent, thus retarding the attaching process. As this competition takes place on the fibre only, these agents are called " affined to the fibre ". They are used in the amount of 0.5 — 2 grams per litre of the bath.

The chromolane dyestuffs (1 : 1 metal-complex dyes) differ from standard acid dyestuffs by requiring a substantial concentration of acid for attaining a level dyeing, while the before-mentioned dyestuffs behave in an opposite manner. If however, a higher concentration of acid is used (8—12% of the weight of wool), a level dyeing is attained but during an extended boiling danger of proteolysis occurs (i. e. injuring of wool). This can be partly suppressed by addition of e. g. Syntegal B or D.

Non-ionogenic agents (e. g. Slovaton CR) have proved as suitable levelling additions. During the application these agents form complexes with the dyestuff and the dye diffuses slower than the non-agglomerated dyestuff without any additions. The attaching is therefore retarded and a better levelling is obtained. These additives have not, therefore, any affinity to the fibre and only partly influence the roughening of the dyestuff. The second advantage of these agents is their capability of amulsifying the residues of fat (e. g. larding oils), which also helps to a better levelling and an increased fastness to wear. At the same time they serve as a protective colloid. Their addition renders possible a lowering of the concentration of acid by one quarter to one third. In this manner it is possible to avoid the danger of proteolysis.

While strongly acid medium is used for dyeing with 1 : 1 metal-complex dyes, 1 : 2 metal-complex dyes enable dyeing even in a neutral medium. As it has been found, that dyeing of wool in neutral medium is not very suitable and that the least chemical activity towards wool occurs in the iso-electric point, i. e. at pH 4-5, an effort has been made to accomplish the dyeing close to this point. A suitable auxiliary agent had to be developed in order to accomplish this without any deterioration of the levelling. A suitable combination of a non-ionogenic character has proved effective (e. g. Slovagen SMK.) This agent retards the attaching of the dye thus increasing the levelling and is suitable for the weakening of colouring and also for stripping. 1–3% of these agents are added into the dye-bath. If the colouring is to be weakened the addition is increased during the dyeing process; an increased addition of the agent is also used for stripping in a new bath.

Somewhat different processes occur during the colouring of material of native or regenerated cellulose than during the dyeing of wool. If substantive dyestuffs are used, the dye is not attached to the fibre. A substantial aggregation takes place in the presence of salts, the aggregates fall apart into individual particles when coming into contact with the fibre; the particles then diffuse into the capillaries of the fibre. The addition of the salt is limited to some extent, as high additions can cause a high aggregation and even precipitation of the dyestuff. Higher molecular anionic soaps, condensates of fatty acids, sulphatized fatty alcohols and sulphatized oils may be used as levelling agents for substantive dyestuffs. They effect favourably the dispersion, wet and simultaneously clean, or even soften the material (e. g. Syntapones, Synferol, AH ex., Neokal pr.). The effect of Retardon A is somewhat different as it increases aggregation, thus retarding the attaching of the dye and is suitable above all for colouring to lighter shades simularly as the already mentioned Slovaton O. (This only in very low doses—max. up to 0.5 grams per litre.) On the other hand, the additions containing pyridine (e. g. Syncarnit P, MA) have a strong dispersive and disaggregating effect; this property can be employed for pasting, for increasing solubility and finally, during the dyeing for improving the colouring.

Special difficulties are sometimes met during the dyeing with vat dyestuffs. Most of these are very rapidly attached to the fibre. This can be prevented either by temperature control, pigment dyeing or by dyeing with a vat acid or by the use of levelling agents. The last method is relatively the simplest.

When a study is made of the course of the dyeing process, it is found that this process consists of a period during which the dyestuff is being attached and a further period during which it migrates and is levelled. As the rate of attaching is considerable, the dyer tries to retard this attaching by lowering the initial temperature. In the case of lighter shades and for colouring of regenerated cellulose which swells already at a low temperature, thus aggregating the passage of the dye-bath, this procedure usually gives unsatisfactory results or is even impossible to be carried out. The increasing of levelling and of the migration of the dyestuff by means of elevated temperatures is not successful, particularly in the case of blue marks which often change their shades. The dyeing process becomes substantially more expensive owing to a higher consumption of steam and the danger of oxidation on jiggres increases together with the danger of precipitation of the vat dyestuff.

It is also possible to retard a rapid attaching by means of the already mentioned Retardon A. Agents on the ethylenoxide basis (e. g. Slovaton O), however, have proved more effective, as they have an affinity to the dyestuff, form larger agglomerates with the dyestuff and thus bind a substantial portion of the dyestuff. On immersing the material into the dye-bath this agglomerate falls slowly apart and a certain equilibrium is attained between the dyestuff and the fibre. The behaviour of these agents towards different dyestuffs varies and sometimes a considerable part of the dye remains in the bath. For this reason it is recommended to test beforehand the dosage for each dyestuff. With regard to the fact that a part of the dyestuff is lost when these agents are used and that these agents are selective towards various dyestuffs it is clear that the applicability of these agents lies only in the range of lighter shades and non-combined dyestuffs.

A different group of levelling agents for vat dyestuffs comprises substances which are not surface-active, have no colloid-protective properties but improve the levelling and migration and do not retard substantially the dye in the bath (e. g. Spolegal GL). When used prior to the addition of hydrosulphite for vatting, they prevent the formation of high-molecular groups. These agents are suitable especially for dyestuffs of the " IN " and " IN spec." types and for the dyeing of medium and darker shades. The additions depend on the concentration of the dyestuff and the time of bathing, and range between 1 and 10 grams per litre of the dye-bath.

Very effective is the further group of levelling agents, which are surface-non-active, low-molecular organic compounds. These have the properties of dyestuff solvents and an affinity to dyestuffs (e. g. Spolegal P). They improve the solubility of the leuco-compound, increase the mobility of the dyestuff particles and their migration. They provide good results with anion-active as well with kation-active additives and are added into the dye-bath in the amount of 0.5–3 grams per litre, according to the composition of the bath. The additions are doubled in the case of mercerized material. These agents are not suitable for padding.

The Ultrazoles form a significant group of dyestuffs. In the case of these dyes, a double dyeing process must

be used, i. e. the impregnation with ultrazole and the developing bath. The Ultrazolates are very sensitive to calcium salts which affect the uniformity of colouring and the fastness to wear. For this reason it is recommended to add protective colloids into the impregnation baths (e. g. Retardon A), which prevent precipitation. During the developing a water-insoluble azo-dye is formed in a hetero-dispersed form. The fastness to wear deteriorates by the presence of rough-dispersed particles sticking to the surface of the material. In order to improve the fastness to wear, non-ionogenic agents (e. g. Slovaton U) are added to the developing baths. These agents influence favourably the particle size of the coloured pigment, thus improving the fastness to wear and the colouring. When added into the soaping bath they help to efface the surface dye and thus improve the fastness to wear. The addition of Syntron B increases the brightness of the colouring.

CONCLUSION

Only the principal and the most common types of levelling agents have been dealt with in this short survey. Even though it is possible to attain a level dyeing in many various ways, the levelling agents in most cases give more reliable results and enable a simpler, less painstaking improvement of the uniformity of colouring and an increase of production capacity.

AEI ALARM SENDER FOR SHIPS' RADIOTELEPHONE EQUIPMENT

A unit to generate the two-tone alarm signal that has been specified as a warning to precede transmission of a distress message on the international radiotelephone distress frequency (2,182kc/s) is available from Associated Electrical Industries Ltd. A compact transistorised unit, the R/T Alarm Generator Type A62 is made by Marine Department of AEI Telecommunications Division. It is fully approved to British Post Office specifications for a non-integral electrically coupled device and will modulate any radiotelephone transmitter.

It has been recommended that all United Kingdom ships carrying radiotelephone equipment should be fitted with alarm generating equipment by January 1st, 1962.

The need for a distinctive signal that can be heard above the speech traffic and other noises of a ship's bridge to indicate that a distress call is imminent has been recognised for some time. The form the signal takes—two alternating tones of 1,300 cycles/second and 2,200 cycles/second, each tone lasting for 2500 milliseconds—and the duration of the signal—30 to 60 seconds—have been specified by the International Radio Consultative Committee (CCIR). The United Kingdom specification for an alarm signal generator, to which the Type A62 conforms, was prepared by the Ship's Wireless Working Party.

Operation of the Type A62 is extremely simple and involves only two controls—a switch to connect the output of the generator to the input of the radio telephone transmitter, and a push-button to initiate the alarm signal. The duration of the signal is controlled by a thermal relay. The two-tone signal can be monitored aurally by a built-in miniature loudspeaker.

The unit operates from the normal ship's 24 volt battery supply. Housed in a robust metal cabinet, grey hammer finished, the unit is readily installed in any position on bulkhead or bench. No extra equipment is required apart from a twin battery cable and three-core screened cable to connect the signal output to the microphone circuit of the transmitter. The equipment is easily removed from its cabinet for servicing.

BRIEF SPECIFICATION

Frequency of tones	2,200c/s and 1,300c/s (±1.5%)
Duration of tones	250 milliseconds ± 50 milliseconds
Level of tones adjustable	each to the other within range 0–6 dB
Interval between tones	not more than 50 milliseconds.
Duration of alarm signal	at least 30 seconds, not more than 1 min.
Output power	−20 to + 6 dB relative to 1 mW.
Loading impedance	30 to 300 ohms.
Supply voltage	24 Volts DC.
Current consumption	200 mA.
Working temperature	−15 to + 55 degs. C.
Overall dimensions	Height Width Depth 5.437 × 4.187 × 5.25 inches 13.8 × 10.62 × 13.3 cms.
Weight	3 lbs. 10 ozs. (1.644 kg).

Recent Trends in the Development of the STAL Turbine

By Carl Larsson,
STAL, Finspong

THE growing size of turbines calls for greater exhaust areas. This requirement has led to the designing of the STAL Durax turbine. The historical background to this development is briefly sketched out. Methods of improving turbine efficiency, the selection of suitable turbines for nuclear power-stations, and governing systems, are also discussed.

In the field of steam-power, developments have been in the direction of ever larger machines. Turbine units rated at 325 MW are in service to-day while 550 MW units have already been ordered. The main justification for the large unit is the lower plant cost per kW. Furthermore, an increase in size implies reduced fuel consumption and lower costs for operating personnel. Since the optimum size is a certain percentage of the total network output, and the networks are growing rapidly, a continued increase in ratings can be expected, both because of the merging of small networks and because of increased consumption of electric power. At the same time, steadily increasing fuel prices have called for improved efficiency, and development has, therefore, been in the direction of higher steam pressures and temperatures with reheating in one or more stages. The higher steam pressure also justifies and increased number of bleeding points for feed-water heating.

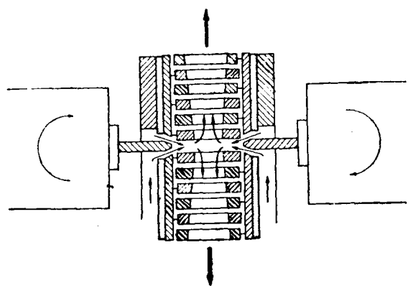


Fig. 1. The original Ljungstrom radial turbine in which the steam is admitted into the centre of the blade system and expands radially outwards. Every second ring is attached to the left-hand turbine disc and the others to the right-hand one. Each disc drives its own generator and the discs rotate in opposite directions. (Fr 735)

THE OPTIMUM EXHAUST AREA

The technical limitations in the development of steam power units of larger capacity are mainly connected with the outlet in the case of turbine design. The exhaust area of the blade system must be increased in step with the growing volumes of steam to prevent the leaving losses from becoming excessive. These losses are usually 2–3 per cent and in extreme cases considerably higher.

With a knowledge of the plant and fuel costs, the capitalisation factor and the number of operating hours per year, it is possible to calculate the value of a change in turbine efficiency. Here, of course, plant cost includes not only the turbine plant cost but also that of the entire station. The capitalised value of the change in efficiency should then be balanced against the corresponding change in capital cost. Naturally, the value is a function of the number of operating hours and the output. It should be noted that, even if the cost of fuel is zero, it still pays to invest a marginal amount in the turbine plant to improve the efficiency, provided that the maximum output is required at some stage. The conclusion is that considerable extra costs can be justified by an improvement in the efficiency, particularly when the cost of fuel is high. It is, therefore, necessary to achieve optimum size of all the turbine parts and particularly of the exhaust area, a requirement which in addition is accentuated as unit capacity increases.

EXHAUST DESIGN OF THE STAL TURBINE

The trend towards larger turbine units and, consequently, increased demands on the outlet area can also be seen in the development of the STAL turbine which has progressed from the original Ljungstrom turbine design (Fig. 1), based entirely on radial flow up to the present day Durax type with combined radial and axial flow. With the early demand for larger turbine units, it soon became apparent that the radial turbine was limited with regard to the exhaust area. The introduction of drums into the outer sections of the blade system with two or more blade rows increased the exhaust area considerably, but it was still not possible to cope

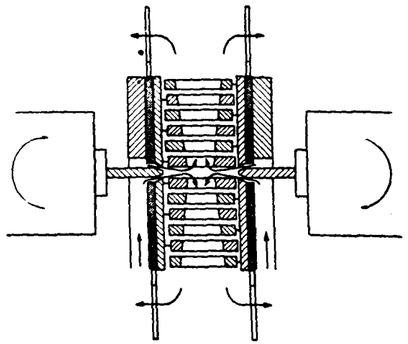


Fig. 2. Double-rotation turbine with the radial blading combined with one axial stage on either side. (Fr 736)

with the large volumes of steam which the development very soon demanded.

As early as 1915, the radial turbine was supplemented by an axial stage on each side of the radial system (Fig. 2) thus giving two exhausts. The relatively long axial blades on a large diameter produced a marked increase in the exhaust area compared with the largest radial blade ring which could be used within the limitations of allowable stress. A development stage which did not, however, increase the exhaust area is represented by the Moller turbine (Fig. 3) which succeeded in raising the efficiency by placing an adequate number of rings inside a smaller diameter, thereby reducing the leakage losses.

An output limit of about 40 MW at 3,000 r/m was soon reached even with the addition of the axial stage. To increase the output still further, the speed was reduced to 1,500 r/m permitting, in principle, a fourfold increase of the output limit. However, the amount of material in a low-speed machine is considerably greater than in a high-speed one, and since the cost of material comprises the major proportion of the total cost of large turbines, it was highly desirable to find solutions allowing of the higher speed, particularly as this often results in better efficiency.

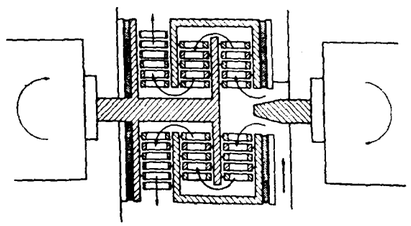


Fig. 3. The multi-disc design. By expanding the steam radially outwards-inwards-outwards the necessary speed ratio can be achieved on very small diameters resulting in low leakage losses. (Fr 737)

Even with the above design, the same limiting output cannot be reached as in a conventional axial turbine, because the design is limited to two exhaust areas while with the axial turbine three or more can be used. Moreover a smaller limiting area per exhaust is available. Due to the axial stages being mounted on the same rotor as the radial system, the hubs on the axial discs are formed with an essentially larger bore than the corresponding disc on an axial turbine. This results in greater disc stresses and consequently a smaller outlet area corresponding to the maximum allowable stress.

THE DESIGN OF THE DURAX TURBINE

Thus, the axial flow section should be designed to minimise, or completely eliminate, the disc bore mentioned above. Figs. 4 and 5 show the new turbine

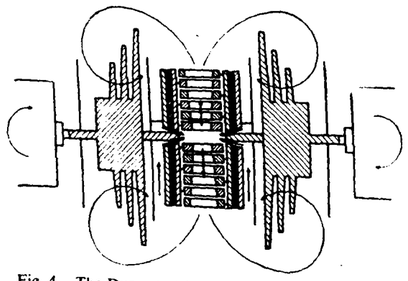


Fig. 4. The Durax turbine with two outlets. (Fr 738)

where the axial section has been placed between the turbine bearing and the generator rotor, which implies the same design as in a conventional axial turbine with the corresponding advantages and disadvantages. This design principle has been given the name of Durax, short for DoUble-rotation Radial-AXial.

The exhaust area has been doubled in the next stage of the development with two axial sections on each side of the radial system, making a total of four outlets (Fig. 6). The rotor can be manufactured

from a single forging, which implies lower stresses than in the case of a disc with a central bore for the shaft.

The introduction of the Durax type has again raised the limitations of the STAL turbine in step with the demands which the market makes upon a

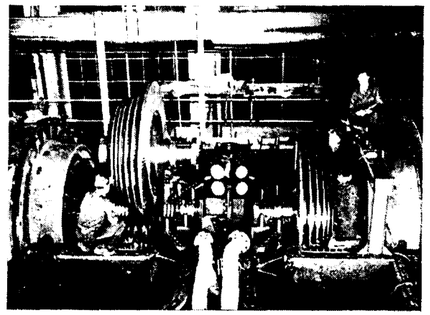


Fig. 5. Mounting the axial-flow blading in a Durax turbine. (F 375)

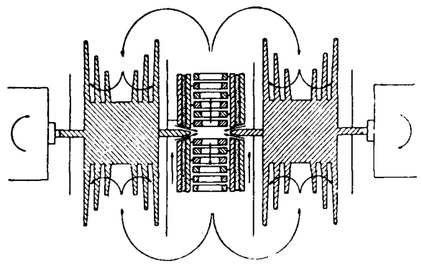


Fig. 6. A Durax turbine with four outlets. (Fr 739)

modern turbine. With four outlets, the total exhaust area, and with it the output limitation, has been raised well above previous limits.

A turbine has been built in accordance with the Durax design with four outlets (Fig. 7) and constitutes the low-pressure set of a reheat plant of 150 MW for the Stenungsund power-station. The first unit of this type is expected to be put into operation in the autumn of 1959. The output of the radial section of this turbine is 60 MW and the combined output of the four axial sections is 50 MW.

This turbine size is, however, at the lower limit for the economical utilisation of four outlets. In point of fact, the same total exhaust areas could be achieved

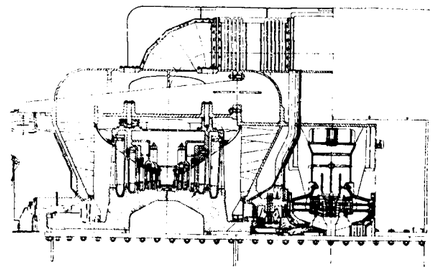


Fig. 7. A 110 MW condensing turbine (type DAK 95) with four outlets and hydrogen-cooled generators (the one half of the set). (Fr 740)

with two outlets within the limiting values for peripheral speed and stress already adopted in the U. S. A. We have, however, found it justifiable to limit this step in development with the intention of increasing the outlet size at a later stage.

The Durax design also makes it possible to obtain large quantities of bled steam at relatively low pressure, for example, for a district-heating system (Fig. 8). Valves in the cross-over pipes from the radial to the axial sections regulate the quantity of steam to the condenser continuously from zero to full quantity as required by the desired ratio between electrical output and heat output. Finally, the Durax principle offers an optimum arrangement of the bleeding points for feed-water heating (Fig. 8). Here we can provide for four bleeding points in the radial system, one in the cross-over pipes and, finally, two in the axial section, resulting in a total of seven bleeding points, which is adequate for most purposes. A larger number of bleeding points may be required in connection with reheating, in which case additional bleeding points can be placed in the high-pressure turbine blading and at the outlet to the reheater.

IMPROVING EFFICIENCY

Exhaust losses

In our development work, considerable attention has been devoted to the problem of exhaust losses as pointed out above, but the exhaust area is not the only factor to be considered in this connection. A large proportion of the velocity energy after the last stage can be recovered in a subsequent diffuser, and we have, therefore, carried out comprehensive investigations of the flow pattern in models in order

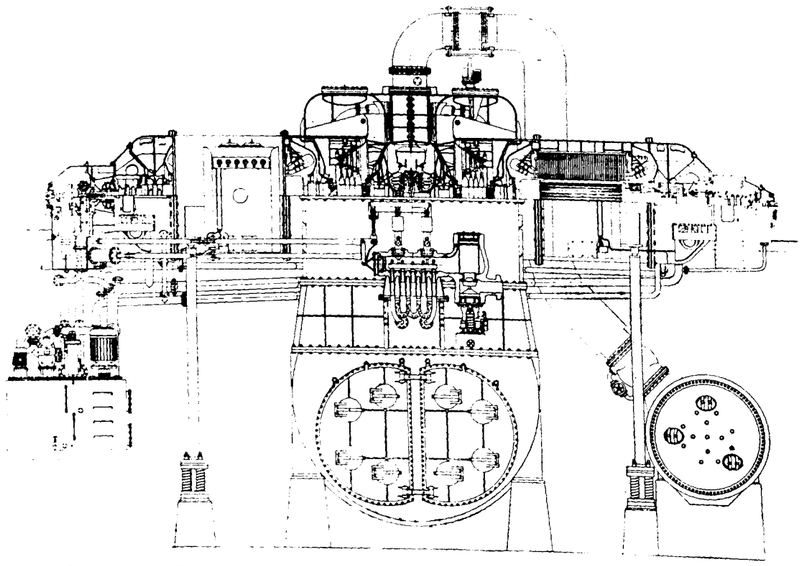


Fig. 8. A 40 MW condensing machine (DAMK 85) with bleeding for district heating. (Fr 837)

to determine the most favourable area distribution both in the diffuser immediately after the axial blading and in the flow path to the condenser. The diffuser after the radial system has also been studied thoroughly both theoretically and experimentally, as have the flow conditions to the axial section.

Hydrogen cooling

Hydrogen cooling of large generators was introduced (Fig. 7) primarily with the object of improving efficiency. It was, however, for other reasons that this system was introduced outside Sweden. Such large turbine generators were being designed that it was difficult to get satisfactory forgings for the generator rotors. However, hydrogen cooling offered the possibility of raising the output considerably while maintaining the size of the rotor forging, and once the technique had been developed, it proved to be economical for the smaller sizes too.

Higher pressures and temperatures

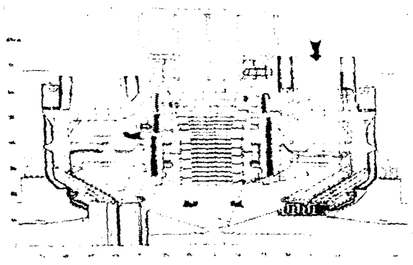
As previously mentioned, the demand for better efficiency guided the development towards higher steam conditions. The development was made possible mainly because more heat-resistant materials became available, but even these materials necessitate considerable redesigning of the boiler as well as of the turbine. While the plant must be designed for high-pressure and high-temperature conditions, the design must also be elastic to allow for thermal expansion and contraction, i. e. a so-called thermo-elastic design, and it may, therefore, be of interest to see how this problem has been in a radial turbine.

Since the steam enters at the centre of the blade system, the turbine parts exposed to high-temperature, and high-pressure, steam are of small dimensions (Fig. 9).

The steam is led into the circular steam chamber assembly through pipes welded to the cool outer steam chamber by an elastic sleeve arrangement, while the inlet pipes can expand radially relative to the hot inner steam chamber. This chamber is positioned axially by guide blocks which permit radial expansion between the inner and the outer steam chambers on dowel pins. At the same time, the guide blocks transfer the large axial pressure forces from the radial labyrinth disc, via the outer steam chamber, to the turbine casing.

The heat transfer to the outer steam chamber is

reduced by thermal shielding, thereby facilitating attachment to the turbine casing. The turbine disc has been designed integral with the stub shaft which, at the outer and cooler end, is fixed to the bearing socket integral with the coupling flange connected with the main rotor. The two outer parts of the turbine disc are guided to the inner disc by means of radial pins, thereby reducing the thermal stresses which would otherwise be obtained due to the temperature drop between the centre of the turbine disc and the periphery.



1. Steam chamber assembly
2. Steam inlet pipes
3. Inner steam chamber
4. Turbine disc with stub shaft
5. Outer turbine disc
6. Inner labyrinth discs
7. Outer labyrinth discs
8. Blade rings

Fig. 9. A 130 MW steam turbine for a steam pressure of 41 atm. and a steam temperature of 565°C (the turbine is designed for a nuclear power-station with oil-fired superheaters). (Fr 741)

The turbine blading shown in Fig. 9 has been designed for a steam temperature of 565° C, for which ferritic material can still be used. If higher temperatures are adopted, it might be necessary to use austenitic materials or more expensive high-temperature materials in the sections exposed to the high temperature. However, in this design, it is possible to limit the use of such expensive materials to the inner steam chamber, the hub of the turbine disc, the inner labyrinth disc, the shaft seal, the innermost rings of the blading system, and the steam-inlet pipes. It is obvious that the corresponding amount of material must be considerably greater in an axial turbine in which it is necessary to place the blades on a large diameter in order to get suitable velocity characteristics. The cost of materials will, therefore, be lower for the radial turbine even if expensive gas-turbine materials are utilised in the critical sections, for example in the inner blade rings. The rotational symmetry of the radial turbine is also superior with regard to thermal shock, as has already been satisfactorily demonstrated by its rapid starting capacity. This is another expression for the thermo-elastic characteristics of the design.

TURBINES FOR NUCLEAR POWER-STATIONS

An important problem is how to adapt the designs for the demands which will be made in connection with nuclear power. It is difficult to predict the design of future turbines for use in nuclear power-stations, but if we confine ourselves to asking what the turbines may look like in 10—15 years, then certain characteristics will stand out. It is already clear that very large units will be demanded and that the reactor temperatures, and consequently also the steam temperatures, will be limited. Therefore, large steam quantities per kW must be expected, accentuating the demand for large exhaust areas. It is also probable that the turbine cycle will expand

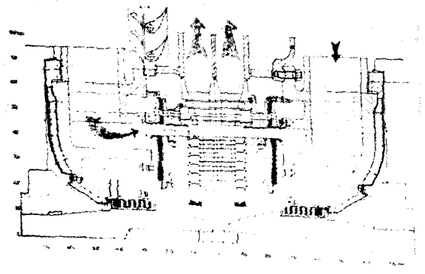


Fig. 10. The radial section of a turbine for a nuclear power-station with two steam pressure levels; high-pressure steam, 40 atm, 336°C, 348 t/h; low-pressure steam, 10.5 atm, 349°C, 169 t/h; output 120 MW. (Fr 742)

further down into the region of wet steam, which will place greater demands on moisture removal and on high resistance to water erosion. It would also appear that some reactor cycles will operate with two pressure levels and the turbine must, therefore, be designed to admit large quantities of steam into the blade system at a lower pressure level.

The requirements for large turbe designs, that is to say, large volume flow and large exhaust areas, is met by the STAL turbine, as exemplified by the design in Fig. 7, which is already in existence. Furthermore, the problem of moisture in steam has been studied

for some time and experiments are still being carried out, but it is still too early to go into details. The radial turbine can cope with the moisture at least as well as the axial turbine, one reason being that there is an excellent possibility of moisture removal in the cross-over from the radial section to the axial sections. The limitations are exactly the same as in any axial turbine with regard to moisture separation in the axial sections.

A very large steam flow can be readily admitted immediately before the axial section if the pressure level is suitable, which cannot always be expected, of course, since the reactor cycle may operate at a higher pressure. There are, however, possibilities of providing a steam inlet in the radial blade system at the desired pressure level (Fig. 10). The design shown in the figure would suit the steam pressure adopted in a number of British nuclear power installations. Approximately two-thirds of the steam flow is admitted in the centre of the blading and expands outwards to about 10 atmospheres at which point the remaining one-third of the steam flow is admitted from an intermediate steam chamber through a channel in the labyrinth and in the turbine disc. The height of the inlet channel is reduced by using it as an axial-flow turbine stage. One row of guide vanes forms the outlet from the steam chamber while the steam channel in the turbine disc has been designed with one row of axial blades. The outer turbine disc is attached to the inner disc in the conventional manner with radial pins through the axial blades. Naturally, the arrangement provides the same possibilities for the extraction of large quantities of bleeding steam.

GOVERNING

Among the novelties introduced on the larger turbines, mention can be made of a new mechanical governing system having foster response coupled with better precision. It allows of both output and frequency governing, in the latter case with an optional load limit. The system also permits the use of secondary governing functions such as back-pressure governing, tie-line load control, etc. Selecting the type of governing and loading the turbine can be effected from central control room by means of electric remote control.

In the case of the largest machines, electro-hydraulic governing will be used. Electro-hydraulic control gear has already proved its worth in the governing of Swedish hydro-electric power-stations and the STAL Company has also experience of its application in the governing of turbines, both in steam power-stations and in gas-turbine power-stations. The advantages of this governing system are its extraordinary response characteristics and precision, and its ability correctly to select the dominant operating signal from a number of superimposed control impulses. This has made it possible to apply boiler-pressure governing and a pre-set automatic schedule for taking up load after a shut-down in a 150 MW reheat steam power unit, thereby achieving the possibility of extremely short starting-up times. With the help of a derivative control device the turbine can be brought back to normal speed after it has been disconnected from the network due to some disturbance, even if the governor has been set to ignore normal frequency variations. The unit can thus safely be kept running until it is again synchronised with the network. The above-mentioned control system can also be used in industrial turbines where the number of control impulses is large.

SUMMARY

The Durax design combines the advantages of the axial turbine when handling large volumes of steam with those of the radial turbine when dealing with advanced steam conditions. The superior efficiency of the radial turbine is a well-known fact and to this should be added the advantages mentioned above. The Durax design also permits bleeding as well as the admission of large quantities of steam; for example, it enables the turbine to be used in a district-heating plant or in a nuclear plant. The design also offers a sufficient number of suitably located bleeding points for the feed-water heating cycle.

(Courtesy: Asea Journal, Vasteras, Sweden *)*

Method for Load Calibration of Testing Machines for tensile Testing of Steel

The Indian Standards Institution has just published IS: 1828—1961 Method for Load Calibration of Testing Machines for Tensile Testing of Steel.

The standard prescribes the methods for load calibration of machines used for the tensile testing of Steel. The machine is calibrated under conditions of increasing load. The three methods of load calibration are covered in this standard are: (a) by standardized weights, (b) by elastic devices, and (c) by proving levers.

LONG LIFE FOR WOOD POLES

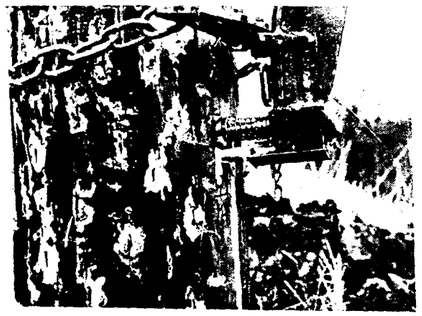
—*the Cobra process described*

By John Mellanby, M.A., A.M.I.E.E., M.Inst.F., M.I.H.V.E.

IN spite of growing competition from other materials, wood still retains a leading position for poles for overhead lines throughout the world, more especially in those applications where the height above ground is 30 ft. or less. Since this includes practically all tele-communication circuits, L.T. distribution and the lower ranges of H.T. up to 11 kV or 22 kV, the extent of the application is enormous. The actual range of use may, of course, vary from one country to another, as for example, in Canada and Northern Europe where tall trees are plentiful, wood pole lines up to 66 kV are often met with, while in treeless deserts it may prove more economical to import other materials. While the main reasons for the continued and growing use of timber are availability and cost, there are technical advantages which are often important. These include simple preparation with ordinary carpenters' tools, high strength to weight ratio making for easy transport and small liability to damage by rough handling and, when properly treated and installed, long life. Appearance must not be forgotten—in rural surroundings poles of a natural material like timber easily blend with their surroundings when metal or concrete might be considered objectionable. Finally, there is a purely electrical advantage which has become increasingly recognised in recent years—this is known as the 'Impulse Strength', and as it may have a bearing on the choice of material for a line, a simple explanation will not be considered out of place here.

The insulation of an overhead line and its associated transformers, generators, switchgear, etc., has, of course, to stand up to the normal working voltage continuously, but it must also be strong enough to avoid breakdown under certain abnormal conditions, the worst of which are caused by lightning. Investigation has shown that surges, induced by lightning, consist of electrical 'pulses' which travel along the lines at a speed approaching that of light, imposing on each insulator as they pass a potential which may easily be 1,000,000 V. Owing to the high speed of travel, this voltage will only be imposed on any particular insulator or piece of equipment for a very short time, perhaps only a few micro-seconds. This, however, is often quite long enough for serious damage to be done, and porcelain or glass insulators may easily be shattered, especially when they are attached to metal poles or pylons. Timber, though not as good an insulator as other materials, and therefore unsuitable for supporting a conductors by itself, is largely unaffected by these surges, so that a wood pole provides what in effect is 'back-up' protection behind the insulator which is only subjected to a part of the dangerous surge voltage. The practical result is that for any given voltage, smaller insulators can be used with wood poles than are necessary with metal, though the advantage decreases as the voltage rises, and at the highest levels now in use the working and the surge pressures are not very different, and the normal factor of safety for, say, 380,000 V will enable insulators to withstand 1,000,000 V impulses

The method of injecting salts into erected poles



A close-up view of the injection head

without difficulty. Summing up, it may be said that this advantage of timber for conductor supports is about at its maximum for 11 kV, the voltage commonly employed for rural transmission, but it may be important up to 110 kV.

Timber has, of course, one serious drawback for use out of doors, through its liability to decay unless protective measures are applied. The speed of deterioration varies greatly in different parts of the world with the species of timber and the destructive agents present. In temperate climates, for example, poles will generally be made from conifers (fir, pine, spruce or larch), and damage may be expected from 'rot' due to the action of fungi at about ground level to be at its maximum. In tropical countries, on the other hand, insect attack is usually more important, especially from termites. Although these creatures are commonly called white ants, they are in fact not true ants, but are closely related to cockroaches. While the generalisation that protection is mainly required against fungus in temperate climates and insects in the tropics, recent research shows that much damage is a combined operation in which more than one agency may take part.

Protection to a greater or lesser degree may be given by the application of various substances, of which creosote is probably the most well-known, but even if the treatment has taken place under pressure, it is found that with the passage of time most preservatives tend to get leached out, and the timber becomes once more vulnerable to attack. The user of timber poles is, therefore, faced with a number of problems—he requires the longest possible life after the initial treatment of new poles, and a simple way of replacing preservative which may be lost in the course of time. Economic considerations are of paramount importance—not only must the initial cost of pole and treatment be reasonable compared with effective life, but expenses due to replacements, including losses due to the interruption of the service, must be fairly assessed.

Amongst the numerous methods which have been evolved to meet this problem, the Cobra system is one of the most interesting and effective—it covers not only the initial treatment of new poles, but also an outstandingly successful way of re-impregnating of poles already in service without any necessity of disturbing the conductors. Different grades of salts are available according to the species of timber, the method of application and the destructive agents to be contended with. Basically, however, all types contain sodium fluoride and dinitrophenol, arsenious oxide being added to the injection grade and whenever termites have to be contended with. The salts are water soluble, and this gives a number of advantages—there is no cost for an organic solvent, and freight is kept at a minimum, while the fire risk is eliminated. It might be thought that this water solubility would increase the liability of the material leaching out after treatment, but this is not the case; wood cells seem to have a property which is not yet fully understood, somewhat akin to that of a non-return valve, so that once the chemical is inside, it can only escape exceedingly slowly. Further stability is achieved by adding a fixative compound which acts in much the same way as a mordant in dyeing by enabling the added material, either colouring or preservative, to 'bite' on to the organic fibres of the material being treated.

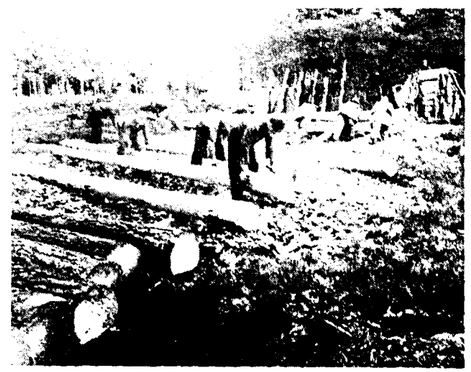
Impregnating new and recovered poles

APPLICATION OF PRESERVATIVE

There are a number of methods of applying preservative material to timber, the simplest being brushing or spraying. This generally gives little penetration, and while it may be adequate when only temporary protection is required, as, for example, during shipment, or in the less arduous situations, it is far from satisfactory for poles standing in the ground. Dipping in a tank of preservative is frequently employed and provided due attention is paid to the type and dryness of the timber, the nature of the preservative and the time of immersion, good results may be obtained with the more absorbent species. In the Hot-and-Cold process, the tank of preservative is heated nearly to boiling point, and after the timber being treated has soaked for the required time, it is allowed to cool, or alternatively the contents may be transferred to a second tank of cold solution. In the Boucherie process, a hole is drilled in one end of a log, and a pipe delivering preservative under pressure is fitted to this, the theory being that when applied to green timber the preservative will replace the sap in the course of a few weeks. There are a number of processes utilising pressure or vacuum to force the preservative into the cells of the timber being treated—in the Pull Cell method most commonly employed, the load is placed in a chamber and air exhausted, preservative is then admittted and the vacuum released. This gives maximum absorption—other pressure processes are designed to recover and remove the excess from highly permeable timbers in the interests of economy. While all the above methods were originally devised for use with creosote, they have also been successfully applied to solutions of Cobra salts, each having its own advantages and disadvantages. Thus the various pressure and vacuum systems require a great deal of equipment which is not easily transportable, and the existence of a central treatment point may easily mean longer hauls. Simple hot and cold tanks, heated by open fires, are often used in the forest itself, branches and waste timber providing the fuel. The non-inflammable nature of the Cobra solution is a great advantage in this case.

The Diffusion Process, which was specially developed for use with Cobra salts, requires the minimum of equipment, and can be carried out by unskilled labour in the forest or any convenient place. The freshly felled trunks are barked and coated using a distemper brush, with a paste consisting of about 12 lb. of salts to 1 gal. of water, the ends being tarred to prevent the escape of sap. The treated poles are then built into stacks of about 36 poles each, and covered by Kraft paper or tarpaulin. With most coniferous timber, penetration takes about three months, after which the surplus paste is removed for re-use, and the poles, after washing, are ready for service. Since the mechanism of the process depends on osmosis and the diffusion of the salts through liquid, it is important that as much sap as possible should be present. To ensure this, the trees should be felled at the right time of year and work started with the minimum of delay, at most within 48 hours.

All wood poles in service are subject to detrioration to some extent, which varies with the species of timber, its initial preservative treatment and the prevailing climate. In order, therefore, to obtain the maximum life, such poles should be given a further treatment once they have become vulnerable to attack but before any appreciable loss of strength has taken place. Statistics show that pressure impregnation with creosote gives an average useful life of between 20 and 30 years, but sometimes failure occurs long before this, especially when the fungus Lentinus Lepideus is present, as this is able to tolerate relatively high concentrations of creosote. Obviously the first step in the treatment of an existing line is a thorough inspection of all poles—this will almost invariably pay off when they have been installed for 10 years or more, but it should be carried out earlier whenever there have been reports of premature individual failures, as it may enable a common cause, such as faulty initial impregnation to be dealt with before the whole system is affected. A thorough inspection is therefore a pre-



The Diffusion Process. Freshly felled trunks being debarked, treated with Cobra preservative salts and stacked at the felling site.

requisite of the Cobra process, and is carried out by specially trained staff. Since most decay occurs in a zone extending from about 18 in. below ground level to the same distance above, this portion is most closely investigated. After removing the earth to expose the lower portion, visual inspection is followed by sounding with a hammer and where necessary the amount of internal decay is checked by an increment borer, which extracts the core from a small hole showing the exact condition of the interior. A report is compiled on every individual pole indicating :—

(a) poles which should be replaced immediately ;

(b) poles which should be changed within a period of up to three years, and which are not worth treating ;

(c) poles which are slightly decayed, but which are expected to have a useful life after treatment ;

(d) sound poles which, after treatment, should have the maximum expectation of life.

On receipt of such a report it is possible to make arrangements well in advance for any replacements and to choose the times when the inconvenience to consumers or subscribers will be at minimum. The normal treatment is to inject a quantity of Cobra salts into the pole by means of a hand-operated pump which forces the paste under considerable pressure through a flat needle which enters the pole parallel to and between the wood fibres, without damaging them in any way ; the depth of penetration being about 2½ in. From 80 to 120 injections are given, according to the size of the pole, the normal quantity of salts being between ½ lb. and 1 lb. After treatment the surface is tarred over and the earth replaced. As the illustrations show, the equipment is simple and easily portable and can be used in inaccessible places without difficulty.

The injection method may also be used in the store yard for new or recovered poles, especially when additional protection is required around ground level in the case of the less resistant timbers, or to supplement pressure impregnation with the less permeable woods like larch or spruce. Where holes or channels have been cut for the attachment of insulators, etc., additional preservative may be brushed over the cut surfaces with advantage. The equipment used for impregnation was designed with softwood poles in view, but it has also been successfully applied to many other species throughout the world. The Cobra process has been in use for over 25 years, during which period more than 10,000,000 poles have received the re-impregnation treatment. The efficacy of the process has been investigated by official research establishments in many parts of the world. Results have shown that the concentrations of salts recommended provide a high factor of safety. Further information on the application of the Cobra system can be obtained from Cobra (Wood treatment) Ltd., 37 Manchester Street, London, W.1, England.

POWER-STATION WASTE ASH MAKES LAND FERTILE

Land in the English Midlands which 10 years ago was a waste of worked-out gravel pits is today producing crops comparable with the best in the area.

The reclamation came about as a result of an electricity generating station in the area producing waste ash at a rate of 2,000 tons a day and there being no easy way to dispose of it. Birmingham University was asked to consider the problem and, as a result of experiments, the ash was used to fill the gravel pits, which were then covered with a layer of topsoil and the land returned to agriculture.

There were difficulties to overcome. The ash was difficult to handle and transport, so it was sluiced into lagoons and allowed to dry out before being removed to the pits in a moist condition. In some areas a pipeline took the ash direct from power station to pits.

One thousand acres of land scarred by gravel pits are being restored to agriculture in the county of Warwickshire alone. Farmers report that the restored land has given very good results. Because it drains easily, it is particularly useful in very wet weather when other fields become unusable, and yet in dry weather the fields remain green because the ash permits moisture to be drawn to the surface.

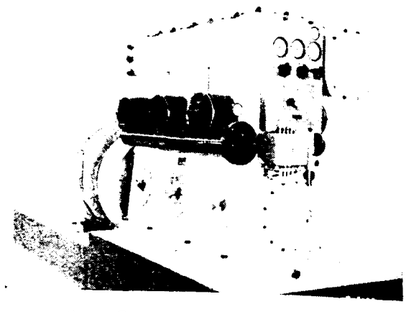
Apart from its use in reclaiming land, ash from power stations is being used in the manufacture of building-blocks with excellent heat-insulation properties. At least one factory is engaged on this type of manufacture.

Czechoslovakia's New Range of Machineries for Export

PISTON COMPRESSORS OF THE DSK SERIES

COMPRESSOR stations are one of the most important equipments in every industrial branch, as they are intended for the supply of compressed air in engineering works, mines, metallurgical works, foundries, etc. The manufacture of compressors is subject to ever new requirements, concerning basically economizing of operation, reduction of weight and enhanced defectless operation. Thus of course, also Czechoslovak manufacturers must solve considerably pretentious tasks.

In Czechoslovakia, however, development and manufacture showed the right tendency as far as technical design and manufacturing aspects were concerned even before World War II. The manufacture of compressors concentrated in the world famous CKD Works in Praha has a tradition as old as the CKD Works itself. The existing series of vertical air compressors with an output range of from 1000 to 10,000 cu. m per hr. for a pressure of 8 atm. g., some of which have attained parameters achieved formerly only by few foreign manufacturers, is based upon these worthy traditions and experience. Among these are particularly the two-stage vertical air compressors of the DSK series, which have proved excellently in practical operation. They incorporate all the advantages of modern high-speed machines, i. e. a small floor area, low weight and the possibility of direct coupling to an electric motor, or any other driving machine. The speed, however, has been chosen in such a manner as to ensure simultaneously a long service life, low trouble incidence and simple servicing and maintenance. The DSK compressor series for a pressure of 8 atm. g. includes outputs of from 1000 to 10,000 cu. m per hr. at a speed of 500 to 250 r. p. m. The crank case of these compressors is of fully welded design. The cylinders and the pistons are cast of fine grained grey cast iron. The differential arrangemnt of the pistons results in the advantage of a uniform and smooth run of the machine. The crankshaft is mounted in cast iron bearings designed so as to enable stripping of the individual bearing shells, or of the complete crankshaft without disassembling the whole machine.



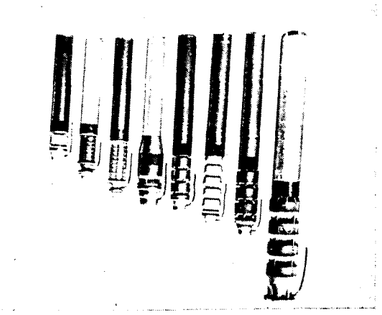
Piston Compressor of the DSK Series

The steel bearing and connecting rod shells are lined with a special white metal. The connecting rod bush is fitted with a lining of lead bronze. The connecting rods are forged and connect directly the crank pins with the gudgeon pins, which are heat hardened and ground. The automatic plate valves ensure correct function of the compressors. The cylinders and the cylinder heads as well as the amply rated air cooler with a condensate and oil trap, mounted between the first and second stage, are water-cooled. The control and checking systems of the compressor are concentrated in one place. The requirements of semi-automatic, or even fully automatic operation as well as of remote control are being considered.

Long experience in and extensive technical knowledge of the problems concerning the compression and distribution of air as well as all types of gases are the best guarantee of economical and reliable operation of all compressors bearing the CKD trade-mark and exported to many countries all over the world by the foreign trade corporation of STROJEXPORT.

SIGMA SUBMERSIBLE PUMPS

Submersible pumps of the renowned Sigma mark solve the difficult problem of pumping water from great depths, narrow bore-holes, inaccessible shafts and great distances. If the water level is below the suction capacity of the pump, there exist several possibilities of pumping the water from such depth. The pump can be submerged below the water level and



Sigma Submersible Pumps

driven by means of a long shaft from the driving engine which is mounted on the surface of the well or borehole. This is the case of deep bore-hole pumps. Another possibility is to mount the pump together with the driving engine on the surface of the well and pump the water by means of the so called deep-suction ejectors. Finally there is also the possibility to connect the pump and the electric motor into one unit and submerge the said unit under the water level. Obviously, in this case the design of the electric motor must be modified so as to permit safe operation under water. To-day all these possibilities have been elaborated to a high degree of perfection.

Submersible pumps manufactured by the Sigma Works cover a wide range of outputs and discharge heads. The Nautila-Jubila and Supertriosa submersible pumps are suitable for particularly narrow and deep bore-holes, as they can be installed in bore-holes of a diameter of 145 mm /6"/. It can be seen from their technical parameters, delivery rate 20—80 litres/min/ 5—21 gal/min/, discharge head 70 m /230 ft/ with an electric motor of 1.1 kW output, that they are intended for private users for domestic water supply installations in family houses, villas, cottages, etc.

Pumps manufactured by Sigma for higher outputs are the submersible Nautila pumps of the U. range which includes submersible pumps for the lowest well diameters of 200—300 mm /8—12 inch/. The range of delivery rates is 60—2500 litres /min/ 13—550 gal /min/ at manometric discharge heads of 15—110 m /49—361 ft/ and outputs of electric motors up to 15 kW. As in many countries the direct starting of squirrel-cage motors above 3 kW is not permitted, the pumps are supplied also with two cables for Star-Delta starting.

For outputs above 15 kW submersible pumps of the Nautila F and G marks are produced in series with the following technical specifications: discharge head up to 200 m /656 ft/, delivery rate up to 300 litres /min/ 660 gal /min/ and well diameters 300—350 mm /12—14 inch/.

All Sigma Nautila submersible pumps consists of a hydraulic section /the pump proper/ and a mechanical section with a special submersible electric motor. Both sections are connected to form one integral unit of a cylindrical shape. The cylindrical shape of the pumps makes possible them mounting and installation in bore-holes with a comparatively small side clearance.

Obviously the electric motor is a very important part of the pump. The special arrangement of the electric motors used in the Sigma Nautila pumps permits permanent underwater operation without any protective devices against the penetration of water into the motor. Electric current is supplied to the motor by a waterproof rubber cable. The discharge branch of the pumps is fitted with a non-return valve. The submersible pumps are suspended directly on the discharge pipe which is held in position by brackets attached to cross beams at the surface of the well.

The principal advantage of the submersible Sigma Nautila pumps is first of all their simple, easy and cheap installation in the well requiring no constructed foundations and no special rooms. As the pumps have no stuffing boxes they require neither attendance nor supervision. Their operation is reliable, safe and noiseless, without suction troubles; the pump runs permanently under water. Investment costs are very low, as Sigma Nautila pumps are simple pumping equipments which do not require an expensive pumping station.

SIGMA RECIPROCATING PUMPS

In recent years the importance of reciprocating pumps has increased as the introduction of ever increasing pressures in, and the progressive automation of, technological processes, mainly chemical manufacturing processes, exclude the use of any other but reciprocating pums. In all cases where liquids have to be delivered in smaller quantities or against high, possibly also pulsating, pressures, or where liquids have to be accurately dosed in comparatively small quantities, reciprocating pumps are necessary.

Reciprocating pumps are used not only in the chemical industry, but also in other branches of industry, e.g. for handling petroleum products, in mines, in the food industry, etc. Also in the field of reciprocating pumps the well-known Sigma manufacturing works satisfies, by the rich assortment of its products, the various and exacting requirements of all branches of industry.

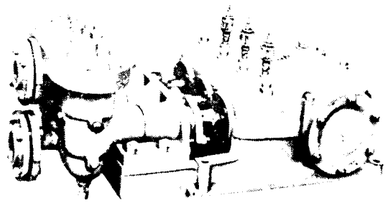
The basic general type of reciprocating pump is represented by the two-cylinder, two-stroke Sigma KDR and DCR ranges with crank mechanisms for deliveries up to 390 litres/min /86 gal/min/ at discharge heads of 8—50 atm. They are suitable for handling pure liquids and also mechanically polluted refinery products, suspensions and emulsions with viscosities up to 250°E and temperatures up to 120°C. The KDR pumps have either disc or ball valves in a common chamber ; the DCR pumps have cone or ball valves which are individually accessible, and they can be arranged with a heating/cooling/ jacket and a flooded stuffing box.

A further similar basic type is represented by the vertical single-plunger pumps of the Sigma EP range for deliveries of 9—75 litres/min /2.3—19.8 gal/min/ and discharge heads of 10—6 atm. g. These pumps can handle very thick, even pasty, liquids and are used on a wide scale in the food industry.

Reciprocating pumps without a crank mechanism are manufactured in Czechoslovakia mainly for application in the petroleum industry. These are either one- /simplex/ or two-cylinder/ duplex/ horizontal pumps driven by steam or pressure air. The pumps are manufactured in the Sigma KDD, IDD and J ranges for delivery rates up to 730 litres/min /161 gal/ min/ and discharge heads of 8—20 atm. g., and in the Sigma J, DC ranges for delivery rates up to 370 litres/min /82 gal/min/ for discharge heads of up to 50 atm. g. and temperatures up to 120°C.

For liquids at temperatures up to 350°C /refinery oils, etc./ horizontal pumps, without a crank mechanism, of the Sigma E single-cylinder range and RJ two-cylinder range are used for delivery rates up to 1250 litres/min /275 gal/min/, discharge heads up to 21 atm. g, these also being designed with heating jackets.

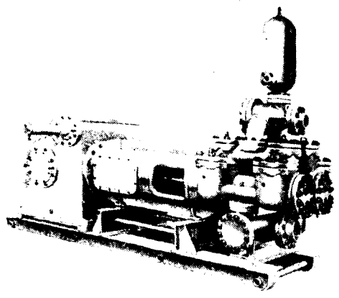
Sigma NT three-cylinder two-stroke pumps of a horizontal design are used for long distance deliveries of crude oil, etc. Their delivery rates are up to 2700 litres/min /594 gal/min/ and discharge heads 70 atm.g. The output of these pumps can be regulated up to 55% of the delivery rate.



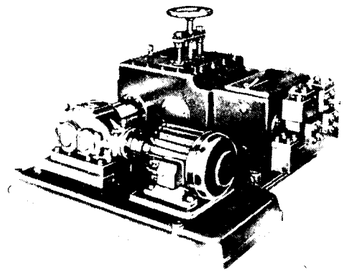
"Sigma High Pressure Plunger Pump MTP"

High-pressure plunger pumps of the Sigma CHTP, H and MTP ranges are available for high-pressure technological processes in the chemical industry. They are intended for handling various chemicals, such as alkalis, acids, liquid ammonia, etc. The maximum operating pressures of these pumps amount to 650 to 800 atm. g. These horizontal three-plunger pumps have a very regular run. Some sizes are equipped with a device for disconnecting the individual plungers as a means of a stepwise regulation of the delivery rate. Plunger pumps for discharge heads up to 2000 atm. g. are in the development stage.

Pumps of the Sigma LPV, LPC, SPV ranges are intended as rinsing and cementing pumps for boring operations. The LPV pumps are of a horizontal



Sigma Reciprocating Pumps LPV



"Sigma DDP Pumps for Dosing Operations"

design, two-cylinder, two-stroke design with a cross-head and crank mechanism for delivery rates up to 2200 litres/min /484 gal/min/ and discharge heads up to 120 atm. g. The SPV range comprises vertical pumps.

Dosing operations are performed by several ranges, such as the DEP. SDEP, DDP and DEM covering delivery rates up to 1000 litres/min /220 gal/min/ and discharge heads up to 200 atm. g. The delivery rates of these pumps can be regulated from zero to maximum according to the respective operating requirements. The construction materials are either standard or stainless steel according to the liquid handled.

Obviously all reciprocating pumps of Czechoslovak make cannot be mentioned in this short survey. However, it should be stated that, similarly to other types of pumps, the Sigma trade-mark also occupies an exclusive position among world pump manufacturers of reciprocating pumps. This is sufficiently proved by the more than ninety years of manufacturing experience of the Sigma-Olomouc works, one of the largest pump exporters in Europe, and by the successful business results of the sole exporter of these pumps, Strojexport, Praha.

FLAMEPROOF ENCLOSURES OF ELECTRICAL APPARATUS

Safety of personnel working in mines or such other hazardous locations where flammable gases could be present, is of primary importance. Though fire in mines could take place by a number of ways, electrical equipment with inadequate flame-arresting property could be one of the causes. With the increased use of electrical apparatus in mines and industry, thus, it has become imperative to lay down the requirements for flameproof enclosures for electrical apparatus.

With this end in view, the Indian Standards Institution has prepared a draft Indian Standard for Flameproof Enclosures of Electrical Apparatus. In this standard, gases have been classified into four groups and maximum permissible structural gaps corresponding to each gas have been laid down. The standard also details other design and constructional requirements necessary from the point of flameproofness.

It is envisaged that such equipment whether indigenously manufactured or imported from other countries shall be tested and certified according to this specification before they are permitted for use.

The draft standard will be shortly put into wide circulation to all interests for comments which will be taken into consideration before finalizing the draft as an Indian Standard.

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NEW BRITAIN-CANADA CABLE LINK INAUGURATED

CANTAT, the Britain–Canada link in the Commonwealth round-the-world telephone-cable system, went into operation when the Queen made the inaugural call to Canda's Prime Minister, Mr. John Diefenbaker, in Ottawa.

The CANTAT (Canadian Transatlantic Telephone) cable was designed by British Post Office engineers. It is unarmoured and laid in deep water across 2,100 nautical miles between Scotland and Newfoundland. It provides 60 two-way circuits.

The complete world cable project will involve the laying of 32,000 nautical miles of cable, and will take 10 years. The second link, expected to be completed in 1964, will be a similar cable across the Pacific connecting Canada with Australia and New Zealand.

The Mohr & Federhaff Universal Testing Plant

By A Special Technical Correspondent

The Mohr & Federhaff Universal Testing Plant—details of which are laid out below, serves for conducting tensile, compression and bending tests, upto a maximum test load of 80,000 lbs, and is equipped with various newly developed regulating and control outfits. The designation of a "*universal*" plant is justified not only by the fact that the above tests can be carried out, but in particular because these tests can be executed under very different conditions.

With this plant, it is possible to conduct :—

- static tests
- dynamic tests
- tests under different temperatures
- tests at a constant rate of loading
- tests under constant loading, over any period of time
- recording of the stress-strain diagramme, with magnification ratios from 1 to 2000.

The single parts of this test plant are as detailed hereunder :

Universal Testing Machine for 80.000 lbs maximum test load—This plant consists of the machine itself and a separate control stand. Loading is made hydraulically, by means of the cylinder located on top of the machine ; the cylinder lifts—via a by-pass frame—the bending table with fitted gripping head, thus permitting to conduct the tensile test in the lower test space of the machine, the compression and bending tests in the upper test space. Because of the two-column design, as well as the location of the gripping heads in the lower part of the machine, it is possible to conduct the most frequently executed test, the tensile test, in particularly convenient operating height ; the test bar is freely accessible from all sides and can thus easily be observed. By a rapid adjustment of the lower gripping head, the distance between gripping heads can easily be varied by means of a push-button control.

The gripping heads are open towards the front side, so that the test bar can be inserted without any displacement of same.

The hydraulic drive consists of a cylinder with friction-free sliding ground-in piston (without any sealings). The hydraulic pressure is thus directly proportional to the load and is indicated on a pendulum dynamometer. Five measuring ranges are available. In the socle of the control stand the special-type high-pressure pump with electric motor is incorporated, which is required for driving the machine. Here also the regulating and control devices are arranged, whereby the equipment of the standard-type machine includes a rapid control as well as a special valve for fine distribution (design M & F). The outstanding feature of this valve is an incorporated pressure regulator, which secures a particularly sensitive setting of the desired load values ; moreover, this pressure regulator effects on the uniform increase of the load.

"FOLLOW-UP" CONTROL AND TESTS UNDER CONSTANT LOAD

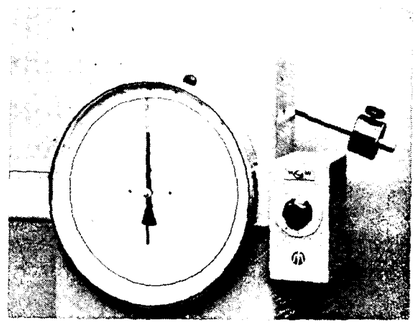
A special feature of the plant consists in the precision Controller which, thanks to its so-called "follow-up" control, secures an unreached sensitiveness in controlling the machine. This set is based on the principle of the Mohr & Federhaff Measuring Plates (Patent). Here, the load increase or decrease is exactly proportional to the rotary motion of the hand-wheel. In the moment when the hand-wheel is stopped, the load remains constant over any wanted period of time. Is the hand-wheel moved again, the load increases—again proportional to the moving speed of the hand wheel—whereby the speed can be slowed down at option. Thus an exact setting of any desired test load is secured in the most simple way, and the set load cannot be surpassed. Moreover, this outfit permits to conduct tests under constant load, for instance creep tests, this system securing really objection-free static loads over any period of time.

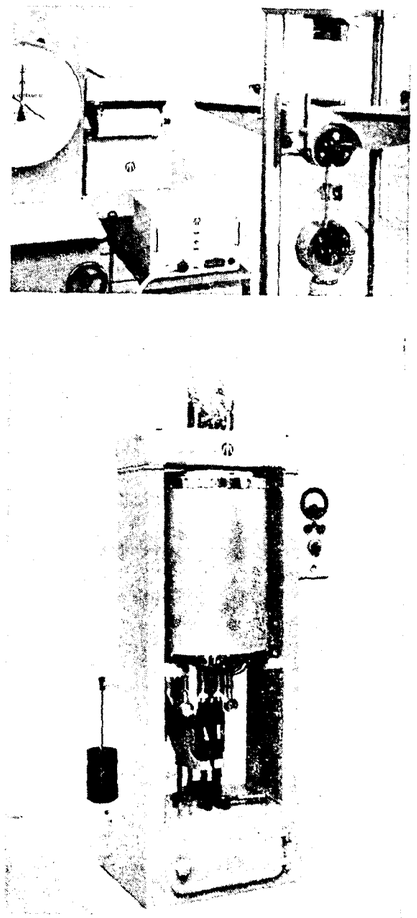
LOAD PACING

Determining the properties of material, the rate at which the load is applied, exerts an influence on the test results obtained. Because of this, it is customary for National Standards on different materials, to contain rules specifying the increment of the load per unit area per second to be maintained during the test. To comply with these conditions, a special Load Pacer has been developed. The indicator dial of the pendulum dynamometer is, in its centre, fitted with an additional rotary disk, for presetting the loading rate. The speed of rotation (corresponding to the loading rate) can be set steplessly on a preselector scale, in a ratio of 1 : 40. To carry out tests at constant rate, it is only necessary to open the valve for fine distribution gradually, until the load pointer moves at the same speed as the rotary disk. Thanks to this special valve, the preset speed can easily be approached and is then nearly automatically maintained. The stepless speed adjustment permits to set various rates of loading for different specimen cross-sections, without having to change any presetting cams or similar devices.

DYNAMIC TESTS

The versatility of the static machine is considerably increased by a load alternator set, permitting dynamic tests (short-term tests as well as tests over long periods of time) with frequencies from 1 to 60/min. This set is a self-contained unit which is arranged besides the control stand of the main machine. The load limits are set by actuating two handwheels, one of which for the pre-load, the other for the main load. These loads are automatically maintained constant by





The Mohr & Federhaff Universal Testing Plant.

hydraulically controlled units working practically without any inertia and which are not subdue to wear.

The frequency is regulated by means of an electronic control and there are only two knobs provided to preset the loading and the unloading time, independent from one another.

This unit permits to widely regulate also the characteristics of the loading curve, for instance loading and unloading can fellow each other continuously, or the pre- as well as the main load can be kept constant over a steplessly adjustable period of time. Finally, also the inclination of the raising as well as the dropping branch of the curve can be varied.

TESTS UNDER ELEVATED TEMPERATURES

For conducting hot tensile tests, a tiltable air furnace is fixed to the machine frame. This furnace is suitable for temperatures up to 1000°C (=1832°F). For securing a uniform temperature over the useful furnace length, at all test temperatures, the loading elements are divided into three zones. All necessary regulating and control devices, for instance a meter, thermostat for cold junction point, multi-switch for the thermo-couples, and the temperature measuring instrument, are incorporated in an extra control desk. Elongation measuring is made by means of extensometers which are led out through the bottom of the furnace. Indication can be made either mechanically or electrically: in the first case, the elongation is indicated on two dial indicators, or by means of the Martens mirror system: in the second case, the stress-strain curve is automatically recorded in connection with the electronic high-magnification recorder.

STRAIN DETERMINATION

The determination of the strain limits, the 0.2% yield point, the proportional limit, the elastic limit (0.01 or 0.005% limit) as well as the modulus of elasticity, is of always increasing importance. For a rapid and exact determination of same, it is a necessity that these values can be read directly from a diagramme. *Our electronic high-magnification recorder* makes it possible to exactly record the strain curve, in high magnification, referred to a defined measuring length.

The set consists in the strain transmitter which is clamped to the specimen, and the receiver mounted, together with the recorder drum, to one side of the pendulum dynamometer.

The elongation of the specimen and thus the axial displacement of the knife edges of the extensometer, is converted by an inductive system into an electric signal which, after being amplified in an electronic amplifier, effects a much magnified motion of the recorder drum, by way of a servo-control.

The load registration is derived from the indicating mechanism of the pendulum dynamometer and takes place parallel to the axis of the recorder drum, with a maximum pen stroke of 200 mm.

To secure a high degree of reliability, the instrument is working according to the zero-balancing principle and, moreover, all components of the amplifier are laid out with a liberal margin of safety. The instrument gives a perfectly steady curve to a high standard of accuracy upto a magnification of 1 : 2000. The transmission is adjustable in various steps, it can be changed over during operation. This makes it possible to draw the beginning of the curve with a higher magnification, and the rest of the curve with a smaller one.

CREEP TESTER

When conducting time-creep tests, it is usual to execute tests for long-time creep determination in single units, and to use for rupture tests the multi-specimen units which require only little floor space.

The new Mohr & Federhaff Creep Tester (Design Siemens) makes it possible for the first time, to execute long time creep determination in a multi-specimen set. This unit permits to test a large number of specimens at a minimum expense and in a small space. Temperature control, switchgear and extensometers are all built-in. This tester does not require a temperature controlled room. Twelve specimens, each about 3" long, are arranged in three strings of four specimens each (Siemens system). Each string is provided with a separate loading device, so that three different loads can be applied at the same time. Loads are variable from 250 kgs (550 lbs.) to 2000 kgs. (4400 lbs). The loading device is accurate to within ± 1%. The stresses within a string of specimens can be further varied by selecting different diameters for the specimens. The strings of specimens are suspended by universal joints and loaded at the lower end by a two-lever system. The lever system can be balanced to zero by means of a compensating weight. An automatic device removes the load, should the specimens cool unintentionally. A monitor provides against excessive temperatures. Water jackets prevent radiation of the heat downward or upward toward the extensometers.

The extensometers located under a transparent hood continually indicate the mean elongation along the opposite sides of each specimen.

SPARK MACHINING

Technical Sales Manager
Welsh Metal Industries Ltd., Caerphilly, Glamorgan

IN recent years spark machining has become an accepted method of cutting metal, principally in the tool and die making field, although production work is now being undertaken by the process. Briefly, spark machining, also called electro erosion, is a process for cutting metals by means of a series of electric sparks between electrode and workpiece. A tool, usually called the electrode, is made to the reversed shape of the die form to be machined. The electrode and workpiece are then mounted in the machine and immersed in paraffin (kerosene), and a series of sparks are passed between the electrode and the workpiece causing metal to be removed from each. The electrode is progressively fed forward to maintain a constant spark gap. In this way the shape of the electrode is impressed in the die.

The process does not rely on a chip method of metal removal, and can with similar ease cut both soft and hard metals; hardened steel, tungsten carbide, nimonic, etc. The ability to cut hardened steels is one of the main features of spark machining obviating, as it does, the wastage due to heat treatment distortion and cracking. The ability to cut tungsten carbide has also been widely exploited both for drawing dies and for press tools.

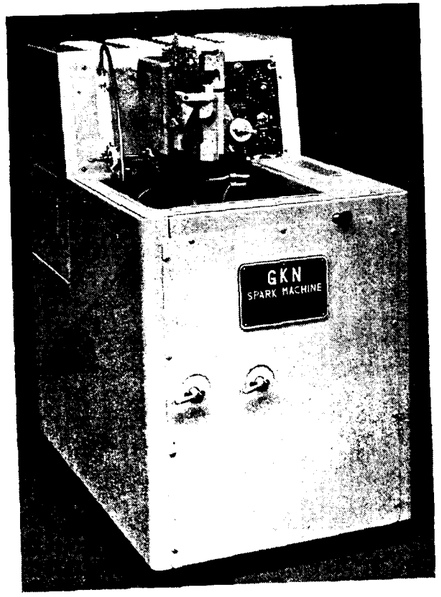


Fig. 1. A typical spark machine.

Because the spark gap between electrode and workpiece is small, in most cases .002", the process can produce accurate work providing, of course, that the electrode itself is accurately made. The normal standard of accuracy is ± .001" but greater accuracies can be obtained, ± .0005" being usual.

The surface finish produced by spark machining differs from the usual machined finish in that it consists of a series of very small overlapping craters, and consequently is matt in appearance. On steel the surface has been shown to be extremely hard wearing, better in fact than the original hardened surface. The surface skin produced by spark machining is very thin and for work such as drawing dies can easily be polished as there are no scratches to be removed. In addition, under this thin surface the base metal, even when in the hardened state, is unaffected.

In general, spark machining is best described by means of examples of work done.

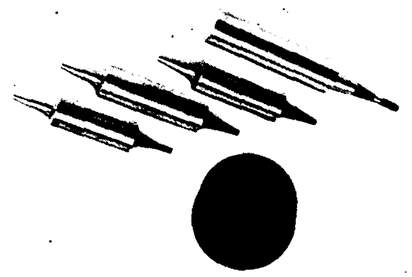


Fig. 2. Round wire drawing die in tungsten carbide.

In fig. 2 is shown a very simple round drawing die of conventional form. Due to the wear on the copper electrodes the taper ones have to be renewed to ensure the correct finished die form. The wear on the three taper electrodes can easily be seen. Firstly, the tapar is spark machined and then, using a combined parallel/taper electrode, the throat is finished. The total sparking time was 3 hours and the accuracy ± .0005″. The tungsten carbide pellet initially had a sintered 5/32″ diameter parallel through hole, but if it had been roughly sintered to form, the sparking time would have been greatly reduced. The rate of electrode loss when machining tungsten carbide is about four times that obtained when machining steel. Had this die been of a complex shape rather than round, the spark machining would have been the same; complex shapes can be sparked as easily as simple ones.

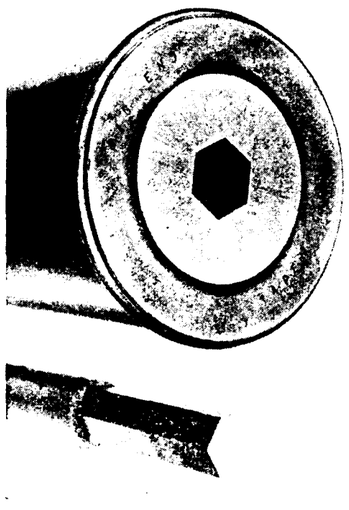


Fig. 3. Hexagon heading die.

A hexagon heading die is shown in fig. 3. The hexagon is .516″ across flats by .303″ deep, and was spark machined in 15 minutes ready for the the heading machine. In this case the electrode is a parallel sided hexagon machined from copper bar. Three cuts are made, each to the finished depth less the small spark gap allowance, and between each cut the end of the electrode is faced to give a flat end. At least fourteen dies can be produced from a 4″ long electrode. A simple calculation will show that for this type of work the importance of low electrode loss cannot be over emphasised. To take an example, if the ratio of electrode loss to work loss is .11 to 1 then the first electrode, when advanced 1″, removes .9″ from the workpiece leaving .1″ still to be removed. The second electrode removes 9/10ths of .1″ leaving .01″ still to be removed, and the third will again remove 9/10ths of this, leaving .001″ which is to the required accuracy. Now if the electrode loss had instead been .5 times that of the work loss, then

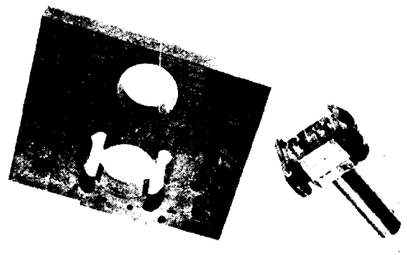


Fig. 4. Die for press tool, motor lamination.

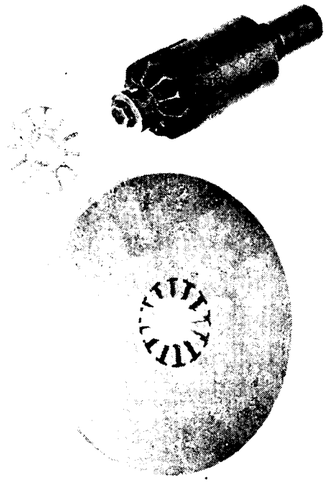


Fig. 5. Stripper plate, motor armature lamination.

the first electrode would leave .333″, the second .111″ and so on, the sixth electrode still leaving .0013″. This gives an indication of the vital importance of electrode wear for all three dimensional shapes.

A difficult press tool die is shown in fig. 4. No difficulty at all is experienced in the sparking, the major difficulty lies in the manufacture of the electrode. This is, in fact, the most common problem in spark machining, but usally a little ingenuity can simplify the apparently difficult job. In this case the electrode was made up of a series of ⅛″ thick copper plates, each of which had been machined by a routing technique using a mild steel template. They could, of course, have been made by filing from a template or by means of a punch shaper. However, routing, or profile milling, of copper is simple and can give accurate electrodes. As spark machining is not a rapid remover of metal, that is it does not compare with the usual chip removal methods such as drilling, milling, turning, etc., it was advantageous to remove the bulk of the form before hardening, and this was achieved by drilling and sawing. Although the comparatively low cutting rate achieved when spark machining has disadvantages for some types of work, it must be remembered that it is a process which cuts hard and tough metals, hardened and tempered steels, tungsten carbide, etc. and can cut shapes which could not be attempted by any other process. The sparking time for this die was 2½ hours and no further finishing was required before use. The tolerance on the sparked form is .001″ and the positional accuracy is of similar order. This die illustrates another feature of spark machining in that forms produced by parallel electrodes feature a small included taper. The reason for this taper is that debris from the sparking face of the electrode passes up the gap between electrode and workpiece and the small amount of side sparking which takes place increses the aperture at the top face. Therefore, by sparking this die from the back face the back relief clearance for the slugs is automatically provided. This taper is about .002″ per side per inch of depth and is nomally sufficient for press tools. It can be increased to about .004″ per side per inch of depth if required.

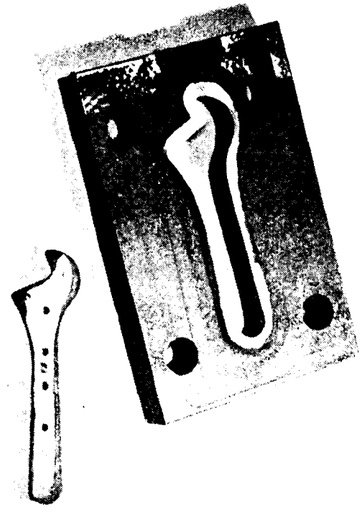


Fig. 6. Clipping bed, spanner body.

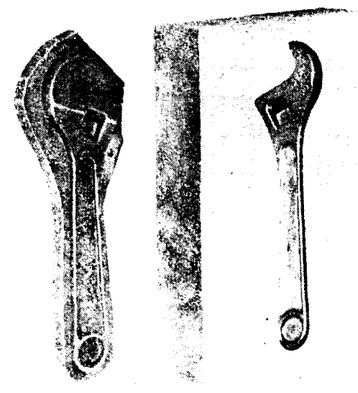


Fig. 7. Forging die, spanner body.

If this taper is not required it can be reduced to insignificant proportions by using short electrodes of the washer type so that side sparking is considerably reduced.

There are many ways of producing complex electrodes by simple means. Fig. 5 for example shows a press tool stripper plate for electric motor armature laminations. A number of these tools were already

in use and from one a number of copper laminations were obtained. These were stacked together as shown and then used as an electrode. It is quite important that stripper plates are accurate to avoid damage to punches and it normally takes a skilled man about 23 hours to hand file one of this type. This one was spark machined in less than two hours and was immediately ready for mounting into the tool. This system of electrode manufacture is also used for die apertures if the tolerance is sufficiently wide, say

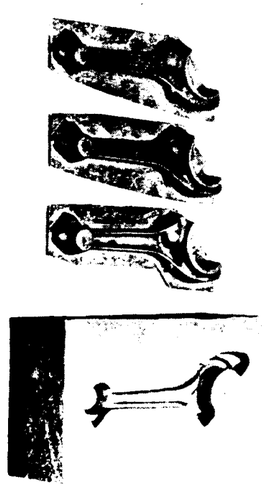


Fig. 8. Forging die, connecting rod.

± .005". Another method of simplifying electrode making is to split a complex shape into a number of simple shapes which can easily be made, these can then be used separately as electrodes to produce the form or can be joined together to make a single electrode. In the latter case brazing is not recommended as the rate of loss of braze metal is high compared with copper, a line is produced on the die, and occasionally the braze will completely fracture. The easiest method is to use copper screws, although even in this case the screw head may on taper forms very slightly mark the die, though usually not enough to affect its performance. No such marking will occur on parallel holes.

Spark machining does not only allow the production of normal dies more cheaply but permits advantage to be taken of better materials not usually utilised due to the difficulty of working or cost. A typical example of the use of better materials, which could not be previously used, is shown in fig. 6.

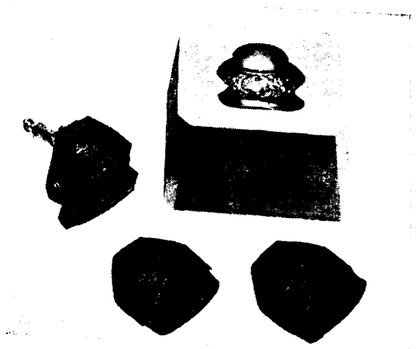


Fig. 9. Stamping die, brass shells.

The conventional method of making a drop forging clipping bed is to use a medium carbon steel sawn and hand filed. These beds have a limited life and have to be continually corrected for size. If on the other hand a better wearing material is used then the problems of production can be acute due to the difficulty of machining. Spark machining can overcome these problems by its ability to cut hard metals. The cutting edges of a normal bed are firstly cut back and then coated with stellite, the top surface ground flat, and the correct aperture sparked in the normal manner using a plate electrode. The sparking time varies depending on the amount of stellite to be removed, but times ranging from one to three hours are typical according to size. This method of making clipping beds is now widely used, as the bed has a much longer life as well as being initially more accurate. Again the importance of low wear of the electrode is emphasised by the fact that a plate electrode can be used ; a $\frac{1}{2}$" thick copper plate will make two or three beds. The plate can be easily shaped by profile milling, routing, etc.

Another important class of dies are those of a three dimensional nature. One such die is shown in fig. 7

and is a drop forging die (the flash gutter had not been cut) for a jackdaw spanner body, and here again the only problem is the manufacture of the electrode. This can be made by normal machining methods, but except in special cases this can be as expensive as making the die itself. The electrode shown was made by cold pressing into a master die. In general, where steel can be hot forged, copper can be cold forged and this is a simple method of making electrodes. For a number of die forms an even simpler method of electrode making is by metal spraying, which is now a well-

Fig. 10. Medal die.

known process. It will be noticed that the face of the electrode has a number of small holes via which dielectric fluid is forced through the gap between the electrode and workpiece. This flow is to wash the debris from the work zone and is most important for efficient operation. Flow through the gap is used wherever possible. The time to spark this die was about $2\frac{1}{2}$ hours but, as in all spark machining operations, the process is automatic once set and started. The machine will then run until the full depth is reached, when it will switch itself off. Therefore, depending on the time cycle of the work, one operator can man up to six or more machines at the same time.

Another example of a drop forging die is shown in fig. 8, together with the three electrodes used. When sparking three dimensional forms it is necessary, due to electrode wear, to use more than one electrode if a dimensionally true form is required. In most cases three will produce a satisfactory form. If a number of dies are to be made, however, then subsequent roughing can be done with previously used electrodes, which means that after the first die the nett consumption of electrodes is one only per die. The total time for this connecting rod die is 10 hours without preforming. Whilst the removal of metal in the soft stage is usually advisable, in the case of three dimensional forms roughing by conventional methods is not easy and the extra time spent spark machining is of little moment, bearing in mind that the extra time is mostly machine time and not labour time.

A further example of a stamping die is shown in fig. 9 and is for the production of shells for the manufacture of plated metal salt cellars. The interesting feature of this die is the detail reproduction. The electrodes were cold pressed but can also be produced by hot pressing followed by cold coining. The die took 9 hours to spark machine, and like all forging dies can be used in the sparked condition without any extra finishing. The single flow hole can be seen on the electrode and the resulting pip is easily removed by a hand stone.

Another class of work is seen in fig. 10, this being a die for the manufacture of medals. In this case the standard of finish required is high, about 30 micro inches C. L. A. obtainable direct from the spark machine. The time to spark this die is 2 hours using copper electrodes, as in all previous examples. Copper is usually the best all round material as it is easily worked and has the properties required for low wear. Other materials such as tungsten copper give a low rate of wear but are hard to work and expensive.

As will be seen from the few examples given above, a spark machine can be an essential tool in the die shop or toolroom, and the process, while still new, is spreading rapidly.

Ready Mixed Concrete Served Electro-Pneumatically

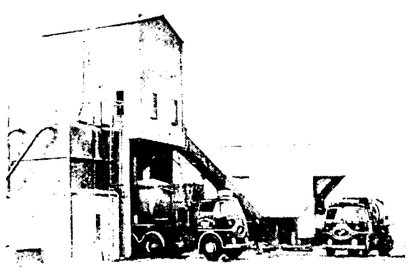
By A Technical Correspondent in UK.

THE Concrete Batching and Mixing Plant, designed and manufactured by Millars' Machinery Company Limited, Bishop's Stortford, supplied to John Henshall (Quarries) Limited, installed at the Sealand Trading Estate, Chester is another step forward in the advance of electro-pneumatic control applied to industry.

Here is a plant, completely automatically controlled by only one operator, at a push-button console, capable of producing 60 cu. yds. per hour of ready-mixed concrete.

The aggregate storage hopper of 48 cu. yds total capacity is divided into four equal compartments, each having a twin outlet fitted with radial type doors, pneumatically operated by 4" bore MAXAM Cylinders. Beneath this storage hopper and supported in the same structure, is an aggregate weigh hopper carried in a precision batch-weigher. The weighing system is connected to a dial head with a remote dial calibrated zero to 8,000 lb. in 10 lb. divisions on a 28" dia. reading line, the dial being mounted on the operators' platform.

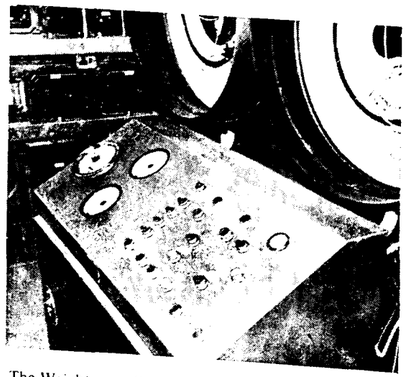
A twin compartment, 30 ton capacity, cement storage hopper is equipped with a pneumatic conveyor and blowing unit for charging a cement surge hopper of 10 tons capacity, this also having twin compartments, each fitted with a ventilator filter in the top.



General view of the fully-automatic Concrete Batching Plant supplied to John Henshall (Quarries) Limited at the Sealand Trading Estate, Chester.

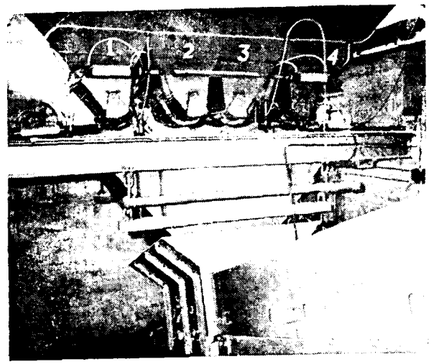
Supported in the same structure, beneath the surge hopper is a cement weigh hopper carried in a precision batch-weigher, this system is also connected to a remote dial calibrated zero to 1,500 lb. in 5 lb. divisions on an 18" dia. reading line, situated on the operators' platform. The weigher outlet is fitted with reverse radial type doors operated pneumatically by 3" bore MAXAM Cylinders.

Before commencing the production cycle the operator positions transistorised photo-electric scanning heads (sited on a ring immediately in front of the weigh dials) to give the required weight of aggregate and cement from each storage hopper.



The Weight-recording dials and control console grouped together for ease of operation.

To begin the cycle the operator presses a START button for aggregate and cement weighing, the two materials being weighed simultaneously. The respective doors open and materials discharged into the weigh hoppers, the doors automatically closing when the pre-determined quantity has been delivered.



A view of the pneumatically operated radial doors in the storage hopper and beneath, the precision weigh hopper which discharges on to the conveyor.

The action of the weight-recording pointer, passing the photo cells on the dial settings, causes electrical impulses to pass to the Solenoid valves which in turn operate the cylinders.

The aggregate doors continue to open and close in succession and lights on the control platform indicate when the weighing of both materials is complete.

This part of the cycle complete, the operator presets the "UNLOAD FOR MIXING" button and the aggregate is discharged on to an inclined troughed belt conveyor, 84 feet long, discharging into a 1½ cu. yd. compulsory paddle mixer. A built in time delay ensures that the cement and aggregate discharge together into the mixer.

The mixer known as the MILLARS' Compulsory Poddle Mixer is highly efficient, the mixing blades, on twin shafts, being so designed as to give a rapid, thoroughly homogeneous, mix. The mixing shafts of high-strength steel run in anti-friction bearings fitted with radial dust-proof seals. Drive for the mixer is by a 50 H.P. Crompton Parkinson motor running at 1500/1440 r.p.m. through a Radicon RHU 12 reduction gear box.

Water is added to the mix by the operator, the amount being pre-set on a Tyler Water Meter. A MAXAM 3" bore cylinder operates the valve controlling the flow of water; the opening of the valve via. the cylinder being initiated by the operator but the closing is automatic on a signal from the water meter.

In addition to the automatic controls the operator is provided with manual over-ride that enables him to weigh directly from the scale, this is particularly useful when on short order work. Electro-pneumatic control is also provided in the cement conveyor system to divert the flow of cement to one or other of the silos when being filled from the Blowing Unit.

The adjustable discharge chute, beneath the Mixer, is designed for discharging to Truck mixers or open lorries.

The mixing unit, control console, switchgear and the vehicle charging point are totally enclosed in a housing of steel frame and asbestos sheet, giving maximum protection and neat compact appearance.

The fact that this plant is operating on a City Boundary raised problems of height, appearance, noise and dust. These points were considered in the designing of the plant, and by building the aggregate weigh hopper and elevator feed below ground level the overall height of the aggregate storage unit was reduced, a similar result was achieved with careful planning of the components in the mixing tower. The pneumatic control equipment, the rubber and canvas conveyor belt with ball-bearing rollers and the silent running paddle mixer all combine, with rigid construction, to reduce the level of noise to a minimum.

The enterprise of John Henshall (Quarries) Ltd., in planning the layout of the site, with modern office, shrub borders and attention to detail, together with the plant supplied by Millars, Machinery Co. Ltd., who appointed Maxam Power Limited to supply and fit all the control equipment, have resulted in a plant that is a new concept in the modern industry of ready-mixed concrete.

Special Applications of Manipulation in Nuclear Power Projects

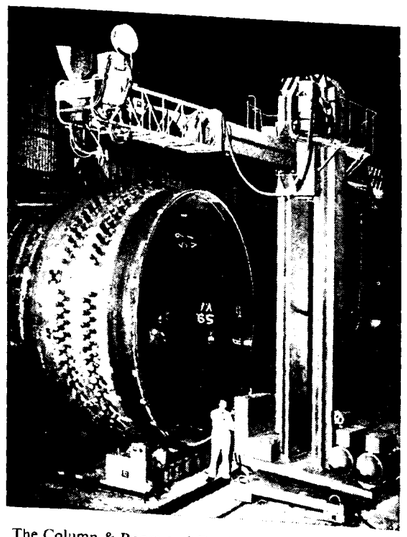
By E. B. Thain—England

THE present trend of development in Nuclear Power Station works has involved many new welding techniques and one major problem is the site welding of the large Heat Exchangers. These are too large to be transported by road or rail and unless both the constructors factory and the Power Station site are adjacent to the sea, then site welding becomes a necessity.

At Trawsfynydd in North Wales 12-350-ton Heat Exchangers measuring approximately 19 ft. in diameter by 100 ft. long are being manufactured on site by International Combustion Limited for Atomic Power Construction Limited, this necessitating the erection of a special site workshop. The single rings, or strakes, are transported to site, but all the remaining work is done in this workshop.

Initially, the strakes are welded together in pairs, this being done on five groups of Rotator sets, each group consisting of a drive unit and two idler units, one of which incorporates a mechanism which can control the endwise movement known as creep, during rotation. This, in the past, has been a big problem as the rotational paths are limited in width and normally there is only a few inches clearance between the Rotator wheel and the banks of thermal sleeves which protrude from the vessel at this stage. Two D. C. geared motors, one in each carriage of each Rotator power unit, are paralleled together to a modified form of magnetic amplifier. This provides an infinitely variable welding speed drive of 6 in. to 72 in. per minute on the circumference of the vessel and gives the constant torque characteristic necessary as, due to the weight of the thermal sleeves, the power necessary to drive the strakes varies and yet the welding speeds must remain steady. The rotator sets are all fitted with resilient mounting blocks, actuated through a pivot bar on the front of each carriage, this enabling the sets to accommodate for some degree of irregularity encountered on the Heat Exchanger faces. The wheels for all the Rotators are rubber tyred which gives the driving friction necessary and a central iron roll takes the actual load.

The illustration shows the Column and Boom and double Strake Rotator Set.



The Column & Boom and Double Strake Rotator Set

Two Welding Columns and Booms, which can either operate in the double strake bay or in the final assembly shop are operator mounted, carrying all the unit's control gear, automatic submerged arc welding head, generators, etc. These machines have eight infinitely variable directional movements, the Boom extends and retracts, elevates and lowers, revolves in both directions, and the complete machine can travel to and fro along rails in the workshop. From a cockpit mounted at the end of each Boom the operator can work any set of Rotator sets, the Column and

(Continued on page 50)

M. I. G. and T. I. G. ELECTRIC ARC WELDING

By A. Courtenay-Snell
Development & Laboratory Dept. of Saturn Industrial Gases Ltd. U. K.

M. I. G. and T. I. G., in welding parlance mean, Metal Inert Gas and Tungsten Inert Gas; two of the principal forms of electric arc welding in use today.

In the M. I. G. process an arc, generally D. C., is formed between a wire electrode and the workpiece to be welded. The heated areas of the workpiece and the wire are protected from oxidation by a gas shield, and the wire is mechanically fed into the arc zone to be melted away and deposited at a high rate on to the workpiece without the use of flux. Various gases are used to suit the materials to be welded and most metal can be joined by this means.

In the T. I. G. process a virtually non-consumable fixed electrode of Tungsten is substituted for the wire, and as this provides no metal transfer, the arc, either D. C. or A. C., is used only to heat the workpiece to fusion temperature. Filler wire, if required, is fed separately into the melt or weld-pool, on the workpiece. This process is also suitable for joining most metals.

Both M. I. G. and T. I. G. have their respective merits, and are complementary rather than competitive. For instance, where aluminium and its alloys have to be welded to the highest standards with a minimum of porosity, or where filler is not required, T. I. G. would be preferred using an A. C. arc, with an inert gas shield of Argon.

In both processes some means has to be provided to initiate the arc, which may also require reignition at the commencement of each cycle in the case of A. C. welding.

A M. I. G. arc may be initiated by momentarily touching the workpiece with the wire electrode, or alternatively, by arranging for a train of sparks to ionise the arc gap and render it conductive. However, a "Touch" start must not be used with any T. I. G. arc since this would contaminate both the workpiece and the tungsten electrode with foreign metal. Originally both A. C. and D. C. T. I. G. arc welding equipments used a train of H. F. sparks for initiation, and frequently in the former case for cyclic reignition also. These methods are now largely superceded by two developments of Saturn Industrial Gases Ltd., of Great Britain.

For T. I. G. D. C. welding arcs, Saturn found that more rapid initiation was possible by changing the continuous train of sparks to a series of discharges substantially of the same polarity as the arc current. As a result they produced a small portable unit embodying this principle which is already well-known in Europe as the Seirion*.

A particular feature of the Seirion, which will appeal to users in places where electricity supply is

* Subject of patent cover

(Continued from page 48)

Boom movements and the welding head, thus having centralised control for the operations. For rigidity and stable movements absolutely necessary in such work, the Column section is of the Twin Pillar design, allowing the Boom to be passed through without causing any twisting moment.

When the double strakes are welded together they lifted by crane to one of two final assembly Rotator sets where they are built into complete Heat Exchanger vessels. These Rotator sets are mounted on free wheel Trolleys so that when the work has been completed they can be towed outside to a suitable position to be picked up by the Goliath crane. Special pedestal support units are used for rotating the conical ends of the vessel.

The problems involved in manipulating and welding Heat Exchangers, cannot be adequately described in a few words, but from the above it can be safely assumed that there exists much in the way of machinery, equipment and technique that can successfully deal with these and other similar problems which may arise.

The "Seirion" for initiating and maintaining a D.C. welding arc is compactly housed in a ventilated steel case.

not available, is that it may be operated from any normal engine driven D. C. welding generator using the electrode as the negative pole. This is achieved by using the actual welding current source to provide power for generating the spark discharges.

The Seirion also incorporates a Solenoid mains operated gas valve to enable the shielding gas to be switched on and off electrically from a distant position, when electricity supply is available.

For T. I. G. arcs operating on A. C. the random spark system has serious drawbacks, which have now been completely overcome by another Saturn product—the Surge Injector. Until the advent of Surge Injection, aluminium welding by this process presented many difficulties.

Straight polarity D. C. arcs were found to give a deep heat penetration, but very dirty welds with much oxide inclusion When the polarity was reversed the oxide was removed but the penetration was poor. Thus the A. C. arc with a combination of characteristics was adopted for this class of work. However, the A. C. arc extinguishes at each reversal of current and requires the presence of a high voltage at the actual instant of extinction for cyclic reignition, which must be higher for ignition of positive half cycles since aluminium is a poor emitter of electrons.

It is possible to maintain an A. C. T. I. G. arc with aluminium once it has been fully ignited, by employing a transformer with a high open circuit voltage, but this is wasteful of K. V. A., is costly, and also presents a risk of shock to the operator, but several thousands of volts are required to ionise the arc gap when commencing to weld.

If the conventional train of H. F. sparks is employed for starting, this entails a delay caused by their random timing, and also produces considerable radio interference during this period.

The Surge Injector does not require more than 42 open circuit volts for satisfactory welding up to 600 amps, and it will work equally well with a transformer, giving a much higher open circuit voltage.

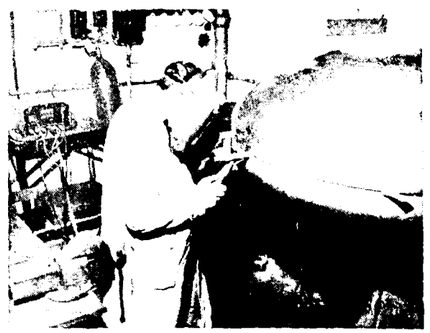
Although a full technical description of this equipment has been published previously it is considered worthwhile to repeat, below, the broad working principles :—

(1) The arc is initiated by a single timed firing pulse of approximately 5 KV which ionises the arc-gap at the commencement of each positive half-cycle, during the starting period.

(2) The pulse is of the same polarity as the welding current which will follow in that half-cycle.

(3) The pulse is derived from a capacitor charged with D/C to about 300/400 volts. The capacitor discharges through a step-up transformer, which transfers a 5 KV. D/C pulse via a spark gap, into the arc.

(4) The pulse is timed by connecting the grid of a triode valve across the welding lines,



Welding a "14 gauge" Copper bowl with direct current and a Seirion to initiate and maintain the T.I.G. arc.

so that this valve will conduct once in every positive half-cycle.

(5) When this valve conducts it transfers a signal to a Thyratron or Neostron valve, and triggers this valve so that the capacitor is able to discharge through the step-up transformer.

(6) The negative half-cycle does not require an open circuit voltage higher than 40 volts for self re-ignition of the arc, hence the firing pulse is only applied to the positive half cycle.

(7) Immediately the arc has struck, the voltage across the welding lines will fall to a value below, 30 volts lower on the negative half-cycle than on the positive.

(8) The arc will ignite, firstly on the positive half-cycle, then when the tungsten has become sufficiently hot to emit electrons, on the negative half-cycle also.

(9) With a fully ignited arc it is unnecessary to employ a 5 KV. firing pulse for succeeding re-ignitions. In fact, 300/400 volts surge is ample for the purpose.

(10) When the negative half-cycle has ignited, the drop in volts across the welding lines automatically releases a relay, which short circuits the primary of the step-up transformer and allows the 300/400 volts surge to pass directly to the welding lines from the capacitor to maintain the arc on the positive half-cycles during welding.

Advantages of the Process

(a) The single timed pulse affords rapid starting with reduced interference in the commercial radio wave bands, and then only during starting.

(b) The arc is much more stable due to the presence of the surge and welding can be conducted at high speed.

(c) Surge Injection gives satisfactory welding with considerable variation of arc length.

(d) The low open circuit voltage reduces considerably the KVA and size of the welding transformer.

(e) The short duration of the pulses and a power source having a low open circuit voltage remove any risk of serious electric shocks.

Equipment used in D. C. M. I. G. Welding

(1) A D.C. welding power source which may be either of transformer rectifier combination or a motor generator.

(2) Consumable electrode wire wound on a spool.

A Mk. IA Surge Injector in use for welding aluminium with an alternating current T.I.G. arc

(3) An electric motor incorporated in the equipment to feed the wire through the welding torch nozzle.

(4) A welding torch which may be arranged for mounting on a machine, or for manual use. In the latter case torches are available which embody both the motor and a small reel of fuse wire.

(5) A cylinder of shielding gas, fitted with a flow regulator, and containing Argon, Carbon Dioxide, or a mixture of both, according to the materials to be welded.

(6) A device to regulate the burn off rate of the electrode wire.

Various means are employed for this latter purpose, which fall broadly into two categories :—

(a) Where the power source has a steeply drooping voltage characteristic, the electrode feed rate, i. e. the motor speed is controlled by the arc voltage.

(b) Where the electrode feed rate or motor speed is set to a constant and the voltage characteristic is nearly flat. The burn off rate is then controlled by the current flowing. This is known as a self adjusting arc.

A bead of aluminium deposited by the M.I.G. tends to possess more porosity and a rougher finish than that produced by T.I.G. welding.

Equipment used in D.C. T·I.G. Welding. (Not suitable for aluminium or its alloys).

(1) D.C. welding power source with drooping voltage characteristic and an open circuit voltage between 40 and 100.

(2) A Seirion to initiate the arc rapidly and instantly to restore it in the event of failure. This is suitable for currents up to 300 amps (to B. S. 638).

(3) An Argon (T.I.G.) welding torch which may be used manually or mounted on a machine.

Similar torches are used for both A.C. and D.C. T.I.G. welding. Where the torch is machine mounted, and it is necessary to use filler wire, such as for butt or fillet welding, the wire is fed by a variable speed motor from a drum or spool into the weld pool via a guide tube usually external to the torch.

T.I.G. welding torches are frequently used, manually or machine mounted, without employing filler wire and using equipment much simpler than is required for M.I.G. which cannot be used for this type of weld.

The method is best suited for light gauge sheet metal, and especially for sealing cannisters where the edges may be bent to bring them parallel. They are then fused together by the heat of the arc to form a seam.

Saturn Industrial Gases Limited produce six types of torches for T.I.G. hand welding ranging from an air model for currents up to 70 amps A.C. or 100 amps D.C. to a water cooled torch rated at 600 amps A.C.

With the exception of three small pencil types these are all fitted with slide switches on their handles to enable the operator to control the equipment without leaving his position.

(4) A cylinder of shielding gas similar to that which would be used for M.I.G. welding.

Equipment used in A.C. T.I.G. Welding (for aluminium and its alloys).

(1) An A.C. single phase welding transformer with drooping voltage characteristic and an open circuit voltage between 40 and 100. This may be embodied in a Surge Injector as in the case of the Saturn Mark II and Mark III equipment, when 42 open circuit volts would be used.

(2) A Surge Injector to initiate and automatically stabilise the arc with remote control from the operating position. If a separate transformer is to be used the Surge Injector would be of the Saturn Mark IA type which will suit any normal single operator welding transformer.

(3) A T.I.G. welding torch of the type previously described fitted with Tungsten electrode to suit the current to be used.

(4) A cylinder of Argon gas fitted with a flow regulator.

The Oerlikon Machine Tool Works, Buehrle & Co., Zurich-Oerlikon, Switzerland

THE Oerlikon Machine Tool Works, Buehrle & Co., originates from the Swiss Machine Tool Works Oerlikon, founded in 1906. Since 1956, the enterprise is directed by Dr. D. Buehrle, and it is owned by the Buehrle family since 25 years.

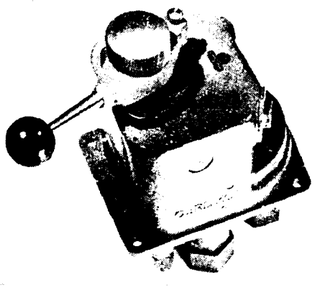
Production:

MACHINE TOOLS

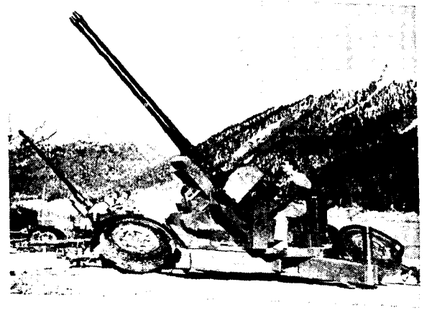
Its repute stems in the first place from the "Oerlikon" machine tools, which soon carried the name far across the borders. Thanks to ceaseless research and development, there is now a wide range of machine tools, namely: high speed lathes, copying lathes, universal lathes, production jig borers, universal drilling machines, spiral bevel gear generators and straight bevel gear planers, and milling cutter and carbide tool grinding machines.

GUNS AND AMMUNITION

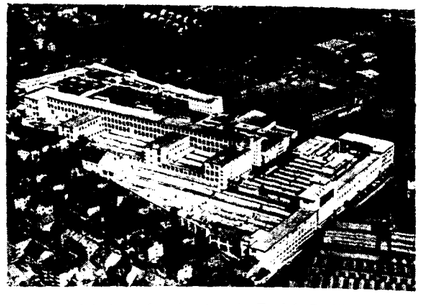
To place the production of the machine tool plant on a broader base, already in 1924 patent and manufacturing rights were acquired for a machine gun from which evolved the famous 20-mm Oerlikon anti-aircraft gun. Among the designs realized after the war, the following have reached production stage:



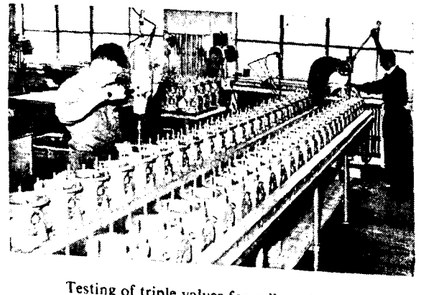
Driver's brake valve for Railways



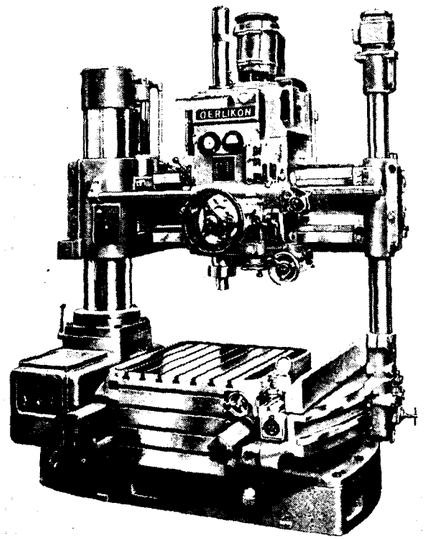
Oerlikon 35 mm Twin Anti-aircraft Gun



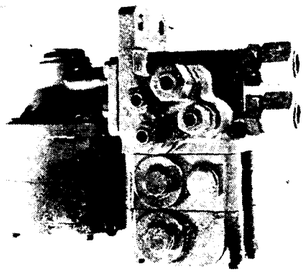
Aerial view of main plant in Zurich-Oerlikon



Testing of triple valves for railway brakes



Oerlikon Jig Borer

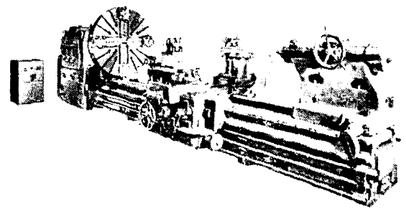


Triple valve for railway brakes

the Oerlikon aircraft gun, the 35-mm twin antiaircraft gun, the twin automatic rocket launcher, and the "Mosquito" antitank wire-guided missile. Oerlikon produces in addition ammunition for its own guns and competing makes as well.

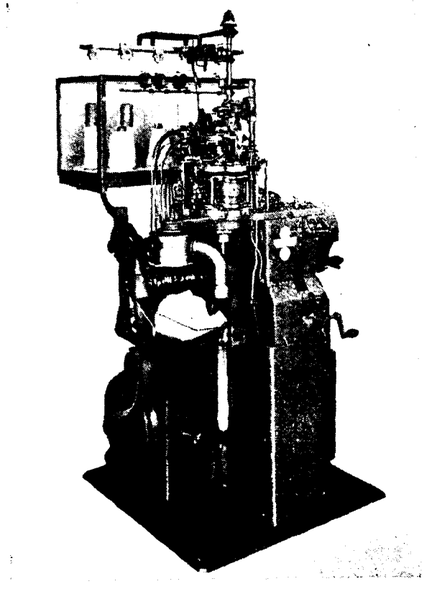
BUSINESS MACHINES

The manufacturing programme underwent further diversification in the post-war years. For Example,



Oerlikon Centre Lathe

the development and manufacture of office machines was taken up and the level of the leading firms in this highly competitive field attained soon; the ULTRA-VOX dictating equipment and the ULTRA adding machines are in fact today among the best. Their most recent baby, the ULTRA-804 printing calculator, a very rapid machine for all standard operations, has lately gone into production. The same section is making the Oerlikon programme control equipment



Oerlikon Circular Knitting Machine for two-feed Ladies' Seamless

Recording Area Weight Measuring Instrument

By Dr. Willy Schnabl & Franz Söldner
VEB Carl Zeiss JENA—Germany

In the field of precision techniques great efforts have been made in recent years in the German Democratic Republic in order to maintain the prominent position held in this field. This position entails the obligation of studying all the various precision measuring problems and of investigating more closely and possibly utilising any measuring processes which may be suitable for precision measuring purposes. Not all precision measuring problems can be solved in the traditional manner by mechanical and optical methods. For many measuring task new solutions have to be found and corresponding processes evolved. Thus, for example, at the moment we are endeavouring to apply electronic and pneumatic methods for precision measuring purposes. The radiation of radioactive isotopes affords the possibility—especially in the field of contact-free precision measuring—of solving measuring problems which could not be completely solved with the conventional methods. This new contact-free measuring process was quickly accepted in the manufacture of continuous bands and foils of metallic and non-metallic raw materials.

First the paper industry took to this new measuring process. The user is interested in obtaining as much printing area as possible, whilst the manufacturer wishes to use only as much raw material as is absolutely essential. Therefore paper is produced and marketed in terms of weight per unit area. Only when the paper was finished a check of the area weight was possible by weighing a certain area, so that only after termination of the production process a decision could be made whether the pre-determined tolerances of the area weight were attained. This resulted either in waste or the area weight were attained. The new measuring process makes it possible to measure the area weight of the paper directly during the manufacturing process, so that now the machine operator can adjust the setting of the paper machine. Similar problems exist in the manufacture of abrasive papers where it is important to be as economical as possible with the animal glues used, but at the same time apply them in the correct thickness. In the manufacture of technical rubber goods, plastic foils, artificial leather, oil cloth and grease-proof wrapping paper great saving can be achieved by using the expensive PVC-material, sparingly. With the measuring methods used so far it is only possible to decide with the finished product whether the PVC compound has been applied too thinly. Reprocessing not only involves uneconomical consumption of valuable raw materials, but also increased working expenditure. Until now the machine operator in this field has been working without adequate measuring possibilities. On the whole he can only rely on his experience. Another complicating factor is that the condition of the PVC compound is subject to great fluctuations in the working of one shift and therefore requires great experience and much skill to work economically. Also some sections of the film industry are open to this new method for the measuring and inspection of the bade material.

When rolling light metal foils, narrow strips are still cut from the edges of the rolled goods and the thickness determined by means of an optimeter. Notwithstanding the fact that these can only be random test, there is a risk that with awkward cutting of the strip the rolled material tears, thus causing appreciable disruption in production. In the steel foil industry is usual to follow the rolled material with a micrometer screw for carrying out measurements. All these methods are auxiliaries sometimes provided by the works themselves, as special measuring instruments permitting continuous measurement and recording with adequate accuracy have so far not been available.

A few figures taken from the literature[1]) are intended to show the great economic advantage which can be obtained with such new measuring methods.

With a medium-sized paper machine it is possible to save 100 to 200 tons of raw material per annum, in the manufacture of artificial leather and oil cloth 1—2 kilos of PVC-compound are saved per 100 sq. metres of finished product. In the film industry a measuring plant on a film-producing machine pays for itself within one year. The volume condensers could be reduced by 13.6% by reducing the paper and metal foil thickness tolerances and this would have a considerable effect on the products of the electronic

industry. The application of radioactive measuring methods in industry and processing works presumes of course that the greatest possible safety precautions are taken to protect staff numbers from harmful radiation and intake, of radioactive substances. The radiation sources are therefore housed in capsules carefully scaled hermetically, so that only the radiation is emitted. Very dangerous intake of radioactive substances, i.e, the absorption into the human body through the mouth and the respiratory organs and through wounds is therefore safely eliminated. As it exceeds the envisaged framework of this article to enter into details of the physical basis of the method of thickness measurement by absorption of B–rays, attention is drawn to the literature (2), (3), (4), (5). All that should be said here is that the absorption of B–rays takes place according to an e-function, the decisive factors of which are determined by the atomic number and the atomic weight of the absorbing material and by the energy of the radiation used. As radiation detector for use in thickness measurements, an ionisation chamber is generally used. B-particles release their energy by ionisation in a pre-determined volume, filled with air or rare gas. The ions produced are collected by an electric field and form an ionisation chamber current. As the currents are extremely small, special electronic methods are

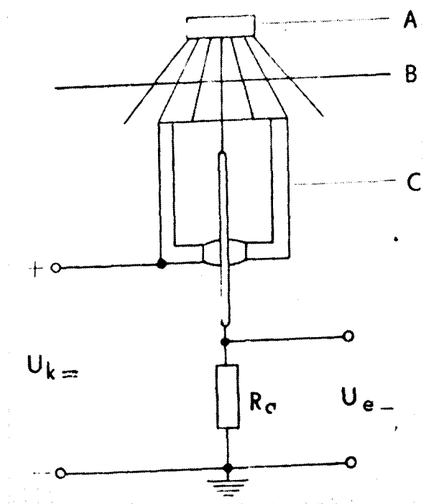


Fig. 1. Arrangement for absorption measurement.
A. radiation source, B. test instrument,
C. ionisation chamber.

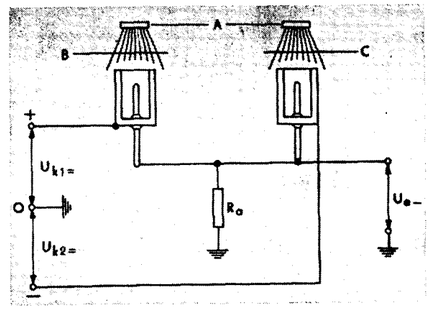


Fig. 2. Arrangement for absorption measurement with 2 ionisation chambers. A. radiation source, B. test instrument, C. comparison material.

required to measure them, in most instances artificial radioactive emitters are used as radiation sources.

Fig. 1 illustrates the arrangement of such an ionisation chamber. The magnitude of the direct voltage occurring in the external resistance is determined by a variety of factors, including atmospheric pressure, temperature and age of the emitter all of which play an essential part. To eliminate these complex components the differential method (Fig. 2) is applied. For this purpose two chambers are used and the material tested is compared with a reference material. The two chambers are connected so that the voltages in the external resistance balance each other if the absorptions of the tests and reference material are the same, temperature and atmospheric pressure effects being eliminated as they apply to both chambers at the same time.

It is of course a pre-requisite that the two ionisation chambers are arranged adjacent to each other to ensure that external conditions are really identical. By means of such a differential method the accuracy of an absorption measurement can be increased considerably. Two specimens must however be used. There is nevertheless the advantage that ageing of the specimens does not enter into the measurement to such an extent as in the above mentioned absolute process. Fig. 3 lists the isotopes which should preferably be used as radiation sources for various measuring problems. It becomes obvious that not any isotope can be used for any measuring purpose. For certain area weights only isotopes should be used which are especially suitable for the selected measuring range. The instrument described below operates with the radioactive isotopes ^{204}Tl and ^{90}Sr as radiation sources.

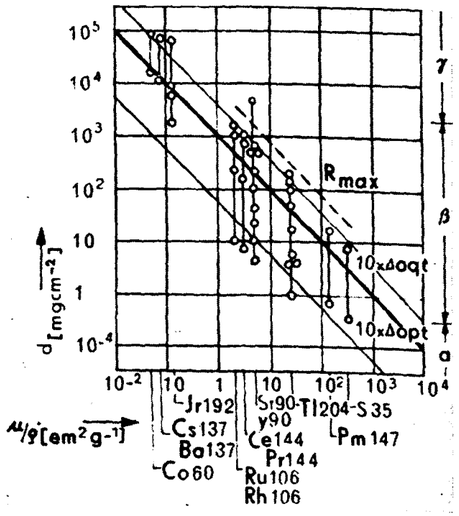


Fig. 3. Diagram for selecting the radiation for a certain measuring task [2]

Numerous technical requirements are placed on a thickness measuring instrument. Special mention should be made of operational safety even with rough and continuous operation as well as the provision of a recording instrument and remote reading. Furthermore a connection for automatic control of production machines must be provided for. Some of the instruments on the market operate according to the so called deflection method (Fig. 1)., others according to the compensation principle illustrated in Fig. 2. The electronic processing of the measured valued can be carried out in different ways. With the more simple electronic process a D.C. amplifier is used which amplifies the voltage produced in the external resistance of the ionisation chamber and makes it visible on an indicating instrument. In this instance a direct voltage is amplified, and the well-known stability difficulties of D. C. amplifiers occur. The difficulties increase if it is required to determine the area weight with an accuracy of at least 1%. Such instruments suffer from poor stability of the zero-point, even where a differential ionisation chamber is used as receiver. To obviate the difficulties with D.C. amplifiers, an oscillating condenser is, for instance, used by which the direct voltage produced in the external resistance can be transformed into a proportional A.C. voltage. This is then further amplified by a considerably more stable A.C. amplifier. Finally it is rectified again and a direct indicating instrument is used.

Fig. 4 shows the block circuit diagram for the measuring process which is used in the instrument described below. Contrary to the unstable deflection method, two ionisation chambers are used, i.e. one differential ionisation chamber which ensures to a large extent that temperature, atmospheric pressure and humidity fluctuations, and also the effects of ageing of the specimen are largely eliminated. The difference voltage Ue produced in the external resistance of the ionisation chambers is corrected to an oscillating condenser which in this instance is energised by the mains frequency of 50 c/s. The A.C. voltage thus produced is amplified in an A.C. amplifier in the usual manner and fed to a phase sentivite electromagnetic servomotor. This motor drives a measuring potentiometer which—fed by a direct voltage—is capable of balancing the charge of the vibrating condenser, and thus the A.C. amplifier acts only as a null amplifier. If the potentiometer has been set so that the output voltage on the amplifier is zero, the currents which produce the torque on the motor disappear. The potentiometer is coupled with a recording device permitting the recording of its position as the measured value. The torques are so great that they produce at the same time a continuous control signal and drive a large reading device. As already mentioned, automatic compensation permits the amplifier to work as a null amplifier and no longer as a deflection amplifier, so that all electronic methods to stabilise it can be omitted. If the amplifier alters its degree of amplification either due to mains fluctuations or due to ageing

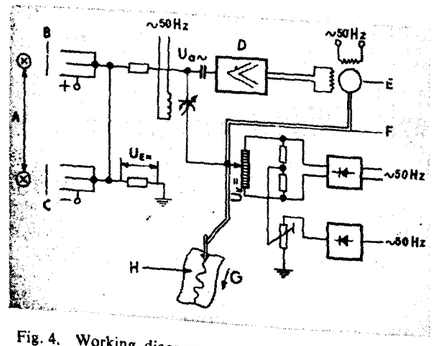


Fig. 4. Working diagram of the instrument.—A. Specimens, B. Material to be tested, C. Comparison material, D. Amplifier, E. Servomotor, F. Mechanical clutch, G. Zero point setting, H. Stylus, J_1. Transmitter. J_2. Receiver, K. Oscillating condenser [3]

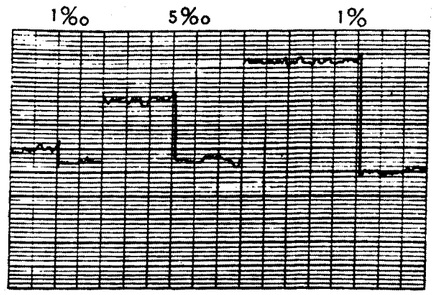


Fig. 5. Sensitivity of Instrument. Area weight steps of 1‰ 0, 5‰ 0 and 1‰ [3]

of the valves, only its sensitivity changes, but never its zero-position and measured value. Thus a very good stability of our measuring instrument has been achieved.

Fig. 5 illustrates the sensitivity of the instrument. The sensitivity can be switched in stages and can be easily reduced by a corresponding increase of the compensating voltage. At maximum sensitivity 1% area weight alterations cause deflections of 5 mm. on the recording paper. This sensitivity by far surpasses the figure required in most practical cases. Only due to automatic compensation methods was it possible to make the sensitivity of the instrument greater than usual despite the small electrical consumption and without the price of the instrument becoming excessive.

Furthermore, the dependence of the instrument on mains voltage fluctuations was investigated. We did not adopt the method of general electronic stabilization of the voltage, but as it is a tone compensation method, the voltage fluctuations are compensated. If the amplifier is subjected to voltage fluctuations, this does not play an important part, as changes in amplification do not affect this system as they do the deflection method. Only a change in the sensitivity of the amplifier occurs and this, however, does not have a detrimental effect because its size is such that sensitivity fluctuations remain, anyway, within tolerable limits.

If the oscillating condenser is subjected to voltage fluctuations, the change in energising voltage naturally alters its voltage output. This dependence is linear. To balance alterations the compensation voltage U_k was made dependent on the mains voltage to the same extent, so that when energising voltage fluctuations and thus input voltage changes occur, the compensation voltage alters accordingly. Fig. 6 illustrates a recorded curve of a measured value, the mains voltage having changed by ± 10 %. Any effect on the measured value cannot be detected. Also with continuous testing of the instrument over 8 hours on a highly fluctuating mains circuit, good zero-point stability was obtained (Fig. 7).

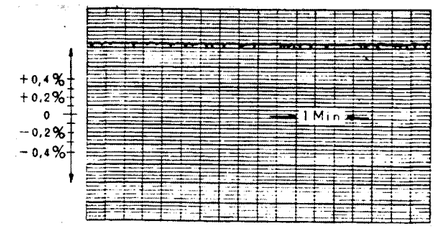


Fig. 6. Effect of mains voltage fluctuations of ± 10% on the area weight indication [3].

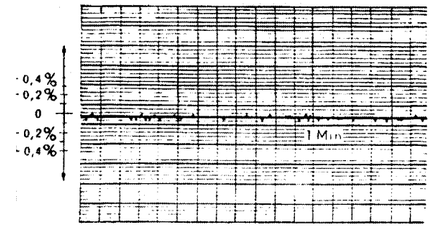


Fig. 7. Section of a record of the zero-point position during an 8-hour continuous test [3]

Then the warming-up of the instrument was investigated. Fig 8 illustrates such a starting diagram recorded with the instrumet at maximum sensitivity. From the curve it can be seen that the instrument—after having been switched on when quite cold—operates even after only 5—10 minutes at optimum measuring accuracy.

When designing the instrument, the many years' experience of VEB Carl Zeiss JENA in the construction of precision measuring instruments fore industrial use was utilised. The design aimed at producing from the existing laboratory instrument a robust measuring instrument suitable for industrial applications. After investigating the possible applications the following indispensable requirements had to

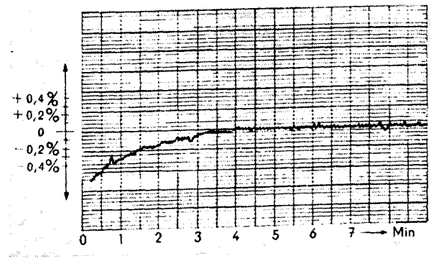


Fig. 8. Starting-up curve as a function of area weight relative to time [3]

be fulfilled, partly by the compensation measuring process and partly in design :

1. Safeguarding of the personnel from radiation injury
2. High measuring sensitivity
3. High zero-point stability with immediate readiness for use
4. Insensitivity of the instrument against disturbing voltages and mains fluctuations
5. Convenient operation
6. Rigid mechanical design
7. High resistance to climatic conditions
8. Possibility of external ventilation
9. Possibility of recording of remote transmission
10. Generating a control voltage for operating the control circuit for automation of a machine or a process
11. Application of the unit assembly system and standard housings to meet the numerous industrial applications with the smallest possible number of standardised components.

Fig. 9 illustrates the standard design of the thickness measuring instrument for industrial purposes.

The following mains units can be recognised :

1. Radiation source (Dimensions : 140 × 190 × 80 mm).
2. Receiving head (Dimensions : 370 × 270 × 200 mm).

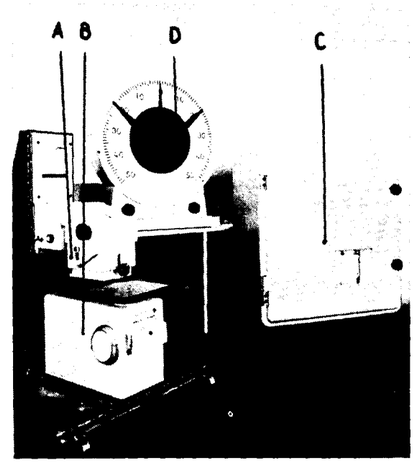


Fig. 9. General view of isotopic Thickness Gauge, with amplifier cabinet, closed

3. Amplifier cabinet with recording unit (Dimensions : 730 × 810 × 390 mm).
4. Large indicating instrument (Dimensions : 550 mm diameter).

The *radiation source* is approx. 50—80 mm above the measuring chamber. It contains as radiating isotopes either ^{90}Sr or ^{204}Tl with an activity of approx. 20 mc. The radiation source is equipped with a warning lamp which lights when the radiator is in working position. If the current is interrupted or the instrument switched off, the specimen carrier reverts automatically to its protected position. The instrument can only be switched on again when the specimen carrier is tilted by hand back into its working position. This ensures effective protection of the operating personnel. The illustration shows a special model for foil rolling works. The radiation source can be tilted away so that there is on obstruction when inserting the foil. The mounting visible is not part of the instrument, but only laboratory equipment. The *measuring head* (Fig. 10) contains the two ionisation chambers of 80 mm dia. and 100 mm height. The window is closed with an aluminium foil and provided with a steel wire guard for protection. Special attention was paid to the measuring head being stable to climatic conditions. The entire internal space is kept by a standardised blue gel cartridge at a low atmospheric humidity,

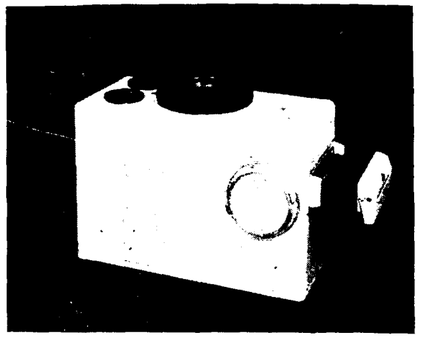


Fig. 10. Measuring head

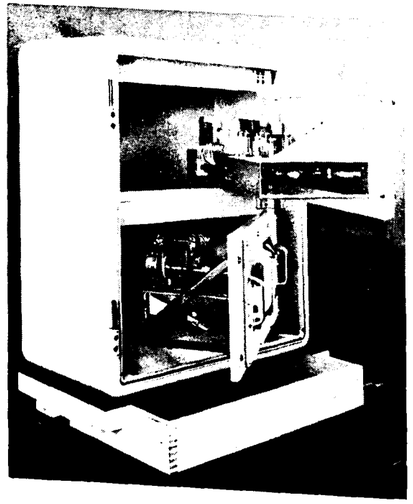


Fig. 11. Amplifier cabinet, opened

the internal space of the oscillating condenser being dried specially. It was frequently noticed that a considerable amount of dust was deposited in places where the thickness measuring instrument was used. The window of the ionisation chamber was therefore provided with a special blowing device with compressed air permitting speedy cleaning of the window. Should the closing foil be destroyed it can be quickly replaced. Adjacent to the measuring chamber is the oscillating condenser with high ohm c resistance and pre-amplifier. The oscillating condenser is designed so that it can also be used as standard unit for other technical control tasks. It operates with an energising frequency of 50 cs. and has, due to the construction and maunfacturing technique, a very high stability of the contact potential. Due to the dry cartridges arranged, the insulation resistance is adequate even in damp climates.

The reproducible manufacture of this precision component is ensured by the respective tools and equipment. The comparison chamber has the same dimensions as the measuring chamber. The comparison radiation source arranged above this chamber can be precision set for exact compensation. The comparison specimen (Etalon) is inserted by means of a rapid-change cassette into the comparison radiation path. The measuring head has surfaces fitted for various supports.

Fig. 11 illustrates the design of the *main amplifier cabinet*. The entire electrical design was accommodated in an airtight aluminium casing. Experience with other precision instruments under industrial conditions proved that only an airtight casing of the shape provided will in the long run meet the exacting demands. Flying dust of 1—2 u particle size will penetrate even through a narrow slit so that only careful packing with long half-life-periods for pressure compensation can be effective. The same applies to the diffusion of corrosive gases or vapours. The sensitive parts of the amplifier can be protected against effects of corrosion by dry cartridges and in specially complicated cases also by air conditioning with pure air. As experience in chemical works showed, this precaution is most important. The valve amplifiers and the recording unit with compensating potentiometer and servomotor are arranged on bases which can be swung out of the cabinet. This arrangement and the clear design of the amplifier permit easy inspection during operation.

To conform with safety regulations, the base can only be swung out by using a tool.

The compensation method permits a simple design of the amplifier. A VEB Carl Zeiss precision potentiometer is used for compensation and this is controlled by a servomotor. The position of the potentiometer is transmitted to a recording instrument. Parallel to it is a rotary control for remote indication and a second potentiometer for producing a voltage for the control plant (roller setting, pulley position, dosing plant, material feed, etc.) By means of an adjustable knob the rotary control can be

shifted so that the zero-point of the remote indicator can be re-adjusted as required. The main amplifier can alter the sensitivity of the instrument via a step switch. The paper feed of the recording unit can be adjusted in two positions.

For band rolling systems, plastics and paper machines a *Large Indicating Instrument* (Fig 12) was designed to allow convenient reading. All operators working in the machines can observe the measured value even from some distance. The large indicating instrument can be read from both sides, the divisions and figures are selected so that they can be discerned even from some considerable distance. Two adjustable tolerance marks permit marking of the permissible thickness tolerance. If the tolerances set are exceeded, an optical or acoustic signal is produced.

If the tape tears, the indicator moves to its final position and thus releases a second signal. This arrangement became necessary because of the requirements of the paper industry where different operators control the exceeding of tolerances and the tearing of tapes. As with other units, the large indicating instrument is also completely enclosed. For using the thickness measuring instrument in the plastic and paper industry for band widths of 1—6 metres, the *mobile attachment* can be employed.

Fig. 13 illustrates the design of this attachment. On a box shaped hollow support the measuring chamber is guided by rollers. Synchronously with it the radiation source moves on a second support of the

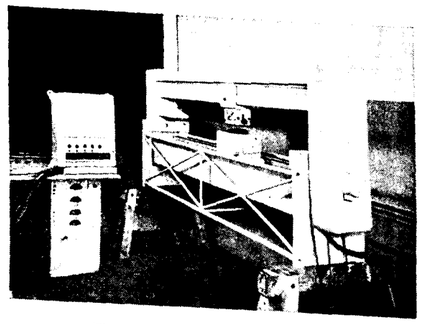


Fig. 13. Cross-motion equipment

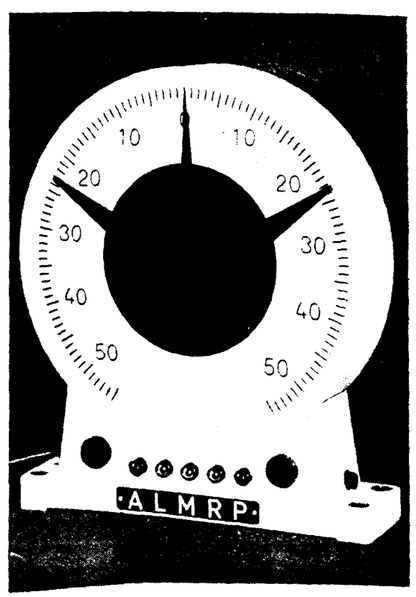


Fig. 12. Large indicating instrument

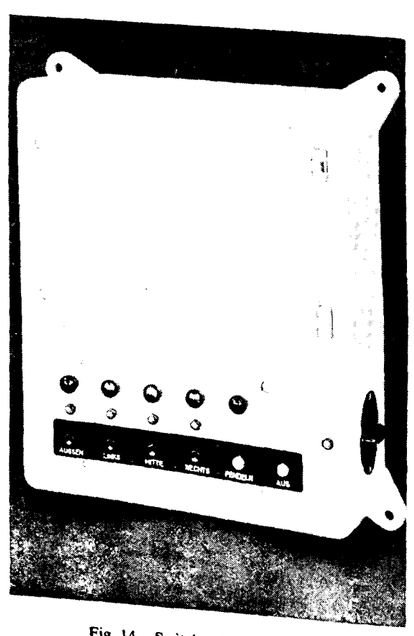


Fig. 14. Switch cabinet for above

same design. Because of the bending and torsion-free design of the supports, span widths of 1 to 6 metre lengths are possible. The guiding tracks have smooth surfaces and the drive is effected through steel rope drives via a reliable and safe slip clutch. Inside the hollow support are lines for electrical power and compressed air. This design has no loose hanging cables impeding operation. The entire movable device is fitted into two pivots and can be tilted so that even obliquely running tapes can be measured. For controlling the measuring equipment a special switch cabinet is provided (Fig. 14). For use in the paper industry the following, ensuring scheme was devised :

1. The measuring device is in a fixed position on the right, in centre or left hand side of the tape. The position required at any time is selected by push button control on the switch box and the measuring device moves automatically into the required position. After completion of the movement the control lamp on the large indicating instrument lights up. The respective position of the measuring head is recorded at the edge of the chart paper so that it is possible to co-relate the measured result.
2. The measuring device moves pendulum-like over the tape. This movement also is released by button control. At the same time this control increases the chart transport speed of the recording unit. The respective position of the measuring head is recorded at the edge of the recording paper so that co-relation of the measured result is also possible in this instance.
3. If the tape tears, the measuring head moves at higher speed into the protected position beyond the tape. A bracket then protects the radiation source and the measuring head against accidental damage when re-inserting the tape.

The thickness measuring instrument can be used to economic advantage in the following fields :

1. *Paper Industry*

The instrument can be used in the wet or dry section. Saving and improvement in quality are ensured by keeping accurately to the area weight. For inspecting the layers a recording unit is required. Automatic control of the feed and other components is possible.

2. *Plastics Industry*

With plastic coated paper the saving of coating compound produces great economical advantages. Uniform quality is ensured. The automatic control of a dosing device is possible. In the manufacture of plastic foils quality and output van be increased.

3. *Oil Cloth and Artificial Leather Industry*

Here there are great possibilities for saving by economical use of the coating compound. Not only is the output increased but also re-processing avoided. The instrument pays its way within a very short time.

4. *Chipboard Industry*

The instrument could be used for measuring the layer thickness after the various processes and thus contribute towards ensuring uniform quality.

5. *Foil Rolling Industry*

By measuring the preliminary roller foil, tape of even thickness can be fed into the finished roller train. This results in less waste, an improvement in quality, and rationalisation of the working method especially at high working speeds.

6. *Film Industry*

In the film industry tape thickness measuring instrument will be used to advantages as the measuring methods used up to now are not fully satisfactory.

The thickness measuring instrument made by VEB Carl Zeiss has the following technical data :

Type of radiation : B-rays

Working principle : Double-beam compensation method with continuously following null point and difference indication

Measuring range : abt 30 to/1000 g/sq. metre

Measuring accuracy : 0.1—1%

Time constant : approx. 1 sec.

Large reading : by direct indicating remote-controlled instrument

Recording equipment : Mechanical recorder

Stability : (a) Warming up time max. 10 min.
(b) Zero-point stability ensured by compensation principle

Elimination of recipe influences on the area weight by use of standards of the same quality.

Exceeding of tolerance indicated by optical or acoustic signal.

Alarm for torn tape with simultaneous movement of measuring carriage. Control voltage by means of a continuously controlled precision measuring potentiometer. Radiation protection when the instrument is not in use and in case of current failure.

Measuring window cleaned by compressed air

Elimination to a great extent, of effects of source ageing as well as atmospheric pressure and temperature, by means of the compensation principle.

Transverse moving device for band widths up to 6 metres.

Protection against dust, industrial conditions and corrosive chemical atmosphere by enclosed units.

LITERATURE

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(5) P. Gorlich, K. Pabst, H. J. Pohl, C. Schacke and W. Schnabl : Kernenergie (Nuclear Energy) 2. (1959) p. 795.

Many Enquiries for AEI 1010—Success at Computer Exhibition

Following on the Computer Exhibition recently held at Olympia, London, the Electronic Apparatus Division of Associated Electrical Industries Ltd. has received hundred of about the AEI 1010 computer.

The tremendous interest being shown in this data processing system is indicated by the fact that the enquiries covered a wide range of interests. These included insurance, banking, consultancy, data transmission and process control. In addition numerous enquiries have been received from universities, Government departments, and overseas organisations.

The AEI 1010 is an extremely fast data processor which can be used for an almost unlimited range of applications. It was the only second-generation computer working at the Exhibition with parallel programming and was able to demonstrate the Rank Exeronic output printer working on-line and printing out at a rate of about 3,000 lines a minute. This was the first time such a demonstration had ever been given in public.

The versatility of the AEI computer makes it unnecessary for it to be tied to any specific peripheral equipment. Systems can be planned to use ancillary equipment of any type such as punch card, paper tape, magnetic tape, drum storage, core storage and output printers.

* * * * * * * * *

£250,000 CONTRACTS FOR AEI MOTORS

Contracts aggregating nearly a quarter of a million pounds in value have been placed with the Motor and Control Gear Division of Associated Electrical Industries Ltd.

Two of these are for electric drives in the steel industry. They include thirty-three motors ranging from 15 hp to 200 hp for Dorman Long (Steel) Ltd., Middlesbrough ; and seven motors of various sizes up to 600 hp, with control gear for Stewarts and Lloyds Ltd., Corby.

Valuable orders have been placed by Ruston Bucyrus Ltd. of Lincoln, calling for fourteen sets of electrical equipment for excavators of different sizes.

PYE TELECOMMUNICATIONS COVER THE WORLD

By A Special Engineering Correspondent

A new method of Trans-Continental communication has been discovered over the past few years ; it is the use of the moon—earth's nearest neighbour in space—to bounce radio signals. The first signals were sent by way of the radio telescope at Jodrell Bank to the U.S.A.F. Research Centre at Cambridge, Massachusetts, using equipment supplied by Pye Telecommunications Limited of Cambridge, England. The Director of Jodrell Bank, Professor A.C.B. Lovell, said at the time that a new means of communication to any part of the world has been opened up by these experiments.

The need for better communications between the countries of the world has existed for a long time. The possibility of meeting this requirement by the use of orbiting man-made satellites is now imminent.

Pye Telecommunication equipment is used in over 90 countries of the world. Subsidiary companies and companies manufacturing Pye Equipment under licence, have been established in many of these countries and there is a constant exchange of ideas and information between them and the Pye Telecommunications factory in Cambridge, England. An example of this is Bharat Electronics Limited of Bangalore, who manufacture the Pye Wireless set "62" under licence in India. In addition, most of the overseas companies have their own development facilities in order to meet the special needs of the territory in which they operate.

Pye Fixed Station equipment is used extensively in Port Schemes.

For sometime Pye have supplied communications equipment to India. At Agra Airport they installed a Pye Instrument Landing System for the Indian Air Force. This is a system for assisting aircraft to land when bad visability prevails and the pilot is unable to see the runway until he is about to touch down. The system, by using radio beams, is able to line up the aircraft with the runway and help the pilot to lower the aircraft onto the threshold.

The majority of India's Airfields are also equipped with Pye Ground to Air 50 watt transmitters and receivers. This equipment is designed to give an amplitude modulated radiotelephone system where extended range is required. The equipment meets the International Civil Aircraft Organization specifications as does the Instrument Landing system.

Pye Equipment is used at the Durgapur Steelworks and at the Chambal-Hydel Power Distributing Project for fixed and mobile V. H. F. Radiotelephone systems. These are just a few examples of the many users of Pye equipment in India.

In Australia each State has a complete radiotelephone network and this is the only means of communication with many isolated parts of the country. To meet the needs of this rapidly expanding market, Pye Telecommunications Limited have recently opened two new factories. The largest is capable of handling a labour force of 1,000 and produces telecommunication equipment for the Australian market, whilst the other manufactures the crystals necessary for this equipment as well as for other equipment manufacturers. A Pye Sales and Service Depot operates in each State to maintain the equipment used

Indian Govt. Airport Control Van

by the local Police, Ambulance, Fire Services and many commercial firms, viz., Iron, Steel and Mineral companies, who employ Pye Radiotelephones as a speedy and efficient method of communication.

In New Zealand demand for Pye Radiotelephone and other communication equipment has increased enormously in recent years. A typical installation is the V.H.F. Ground to Air Control System which was installed for the New Zealand Civil Aviation Authorities. The Control Centre is at Wellington with remote stations sited at Colonial Knob, Paraparaumu airport (which is an alternative Control Centre) and Mount Egmont. These sites are connected to the Control Centre by V.H.F. multiplex links designed specificaliy for unattended continuous operation.

The Pye Company in South Africa has to meet the competition of the Common Market but the increasing demand for Pye equipment is an indication of the competitive ability to meet this challenge. The flow of material, which suffered from temporary restrictions at the beginning of the year, is now reaching its previous high level.

In Rhodesia, and in East and West Africa, Pye Telecommunication products have long been accepted as standard and their Radiotelephone equipment is used in Administration, Security and Commercial organizations throughout the entire territory.

One of the first uses of mobile Radiotelephones was for the control of large taxi fleets. In London, Pye Telecommunication Limited are equipping one of Europe's largest taxi services, the Mini-cab Taxi Company, with over 800 radio controlled vehicles. In Australia alone there are over 300 Taxi and Car Hire firms using Pye equipment and there are large fleets in all Commonwealth countries similarly equipped.

In the Medical services Pye Radiotelephones are used to speed Ambulances and Doctors to the sick and injured. Doctors find radio particularly useful as they can be diverted to urgent cases when on routine visits.

Police throughout the world also use communication equipment for crime and traffic control. For traffic and crowd control the output of the normal radio-telepone equipment can be re-transmitted over an all weather loudspeaker at the front of the car. For crime work, electronic equipment has many ingenious uses, but when the time comes to call in the police, radio communication is usually the fastest means of getting a policeman on the spot.

The value of Pye radiotelephones for airport work is demonstrated by the fact that at London Airport over 500 vehicles are fitted with Pye Radiotelephones. Crash tenders and Ambulances can be briefed instantly as required and petrol bowsers given their instructions. Passenger buses, luggage tenders, service vans and even grasscutters are fitted with Radiotelephones so that they can be recalled or moved quickly in an emergency.

Pye equipment is employed in agriculture throughout the world. On large farms Radiotelephones are used to get maximum benefit from expensive farm machinery. They are also used for ground to air control of small aircraft of the type used for spraying crops. Forestry organisations employ radiotelephones for protection against forest fires. If a fire is spotted then fire fighting equipment can quickly be brought to the scene and many trees saved.

When a large complicated network of communications is required, like the Caribbean Inter-Island

The Pye "Handi-Ranger" being used in Agriculture

Scheme, Pye Systems Planning Engineers take over and, in close liaison with the customer, the necessary plans are prepared.

On behalf of International Aeradio (Caribbean) Limited, Pye completed a major contract which links eleven Caribbean islands by the most advanced aeronautical inter-island and ground to air V.H.F. communications system in the world. This provides, over a route which is more than 830 miles long, high grade radio-teletype and voice circuits between the islands and ground to air communications with all aircraft operating in the area.

For Associated Television Limited, Pye engineers installed a 7000 Mc/s. television microwave link. The link transmits television programmes from Alpha Television Studios in Birmingham to the A.T.V. Foley Street switching centre in London. From the transmitter terminal, located in the centre of Birmingham, the signals pass through repeater stations at Meriden, Cold Ashby and Barkway to the receiver terminal at Highgate....an overall path length of some 135 miles.

New Zealand Ground to Air System Equipment Racks.

Situated at Cambridge there are large laboratories, the staff of which are constantly probing for fresh ideas and keeping Pye equipment up-to-date with new techniques and components. Among the latter is the transistor which will gradually supersede the valve in communication equipment.

One new equipment which uses transistors and cold cathode tubes in the Pye Electronic Telephone Exchange which sets new high standards of speed, efficiency and reliability in telephone systems. This 20-line Exchange is fully automatic, employs no moving parts, is completely silent in operation and provides a convenient intercommunication system for large and small businesses alike.

Visitors come from all over the world to Cambridge to see for themselves the production of telecommunication equipment. Regular visitors to the Factory are colonial students from the Ryton and Dunsmore Police College. As many of the Police Forces from which they come use Pye equipment they find a visit to the Factory a useful part of their stay in this country. The factory has a steady flow of trainees from the Common wealth who come to learn about production and maintenance so that when they return home they are able to service Pye equipment in their country.

Probably the most rewarding field of research for the future is the use of satellites for communication. Mr. J. R. Brinkley, the Managing Director of Pye Telecommunications, Cambridge, England, has recently done some preliminary research into the problems in this field and from his results the following conclusion can be drawn.

(1) Space telephone systems cannot be planned and engineered unless the pattern of the world's communication needs is recognised and understood. That it will follow closely the pattern of ocean borne trade seems reasonable.

(2) Using this relationship it is possible to make an assessment of the need for international telephone circuits between any two countries with sufficient accuracy for initial planning purposes.

(3) The nations which benefit most from space communication development are those with the largest ocean borne trade. First on the list is the United States, followed by the United Kingdom. The benefits to the Commonwealth of a reliable telephone service cannot be over emphasised.

Much of the calculations for the proposed system have been done by the University of Cambridge, Department of Economics. They have also provided much material on the pattern of world trade for the future. The day will surely come when all the countries of the Commonwealth will be linked together by a Satellite Telephone System.

Ultra-Microtome for Electron Microscopy

By A Special Technical Correspondent

THE Huxley Microtome is a new instrument for cutting biological tissues and metal sections for examination by electron-microscopy.

BIOLOGICAL SPECIMENS

Specimens of soft biological tissues need special preparation for examination in an electron microscope. Originally only fragmented material could be examined successfully but the introduction, a few years ago, of two new techniques—embedding specimens in methacrylate polymers and making knives from plate glass—has made it possible to cut sections of suitable thickness without excessive difficulty. The new knowledge gained by applying these techniques and others developed from them is bringing about a revolution in the understanding of living processes, normal and diseased, at the sub-cellular level.

Fig. 1. A Huxley Microtome being used in the laboratories of the Sir William Dunn School of Pathology, Oxford.

To take advantage of these methods a microtome must not only be capable of cutting sections in the range of thickness necessary (10—100mu) but it must also be able to do so with consistent accuracy. The ultramicrotome designed by Mr. A. F. Huxley, F. R. S., conforms to this exacting specification with an outstanding degree of success.

The microtome described in this article is a slightly modified version of the original instrument, built in the Engineering Laboratory of Cambridge University to Mr. Huxley's design, and is manufactured by the Cambridge Instrument Company Ltd., 13 Grosvenor Place, London, S. W. I.

METAL SECTIONS

The examination of thin metal foils by transmission electron microscopy has become an important metallurgical technique, and in order to see the detailed sub-microscopic structure samples must be very thin. For some applications the only way to cut foils that are sufficiently thin is by use of an ultra-microtome.

One example of the use of the Huxley Ultra-microtome being used for this purpose is at Aeon Laboratories, Surrey, England, where sections of silver foil 0.5 mm square and 150 mu (1500 A) thick were cut, using a Venezuelan diamond knife.

THE MICROTOME

Thes Huxley microtome is purely mechanical in principle and its exceptional performance (see below) is achieved partly through close attention to details of design and partly through the incorporation of several special features.

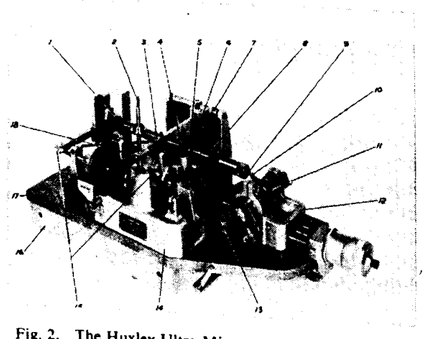


Fig. 2. The Huxley Ultra-Microtome, without its cover. (The numbers are referred to in the text.)

The bar carrying the specimen, and the lever which advances the bar, are both entirely supported by flexible steel strip or wire connections so that backlash, friction, wear, and lubrication difficulties are completely avoided. To avoid vibrations from a motor (a serious possible source of inaccurate sectioning) the instrument is manually operated, the operating arm (3) (figure 2) being lifted by hand between successive cuts and allowed to fall under its own weight for the cutting stroke. The speed of fall is controlled by a plunger (4) in an oil-filled dashpot (5).

The base of the microtome is a solid steel slab, 17.5 mm thick (17), reinforced by two thick steel ribs (16) welded to the underside. The interlocking mechanisms that operate and control the cutting and return strokes and the amount of specimen advance are mounted on a casting (14) bolted to the base. The knife-holder (11), with the glass knife (10), is mounted on a separate movable casting (12) in front of the main part of the instrument. The specimen (9) is supported on one end of the specimen bar (8), the other end of which is hinged (1) to part of the advance mechanism. The specimen bar is linked by an adjustable wire suspension (6) to the operating arm which crosses above it at right-angles and is pivoted (7) at one end. For aligning the knife-edge with the specimen block, the post (2) can be rotated so that a stop (18) will hold the operating arm and specimen bar at the point of cut.

During the return stroke the specimen is displaced to one side of the knife-edge and is also advanced. The displacement (13) and advance (15) mechanisms are completely disengaged from the operating arm during the cutting stroke so that the specimen is isolated from possible sources of vibration within the instrument.

The instrument is protected during use by a translucent fibreglass cover to prevent its performance being affected by temperature variations caused by draughts.

The base slab and the specimen bar are made from similar steel to reduce still further, the possibility of errors caused by slow temperature variations.

PERFORMANCE

The Huxley ultra-microtome will cut sections ranging in thickness from about 10 mu to 150 mu in increments of 5 mu and having an area up to 3 × 4 mm. This states the performance of the microtome in quantitative terms and needs some qualification as the minimum thickness that can be successfully cut and the regularity over a series of thin sections are decided not by the instrument itself but by the mechanical properties of the specimen and the quality of the knife-edge. It is possible however to give some indication of the quality of performance by noting results that can be obtained without difficulty when using a fresh glass knife and a plain methacrylate block containing no specimen.

Fig. 3. Electron micrograph of a thin Ag–1% Al section cut with a Huxley microtome at Aeon Laboratories, Surrey, England.

With the advance set at about 130 mu the floating sections (compressed to about two-thirds their original area by the cutting process) show the first order red interference colour when reflecting white light. This tint is very sensitive to changes in section thickness and becomes orange if the section is thinner and purple if the section is thicker. A ribbon of sections of this thickness shows practically no detectable variations in colour indicating that they do not vary in thickness by more than 1 or 2 mu. This test is carried out on all instruments before delivery.

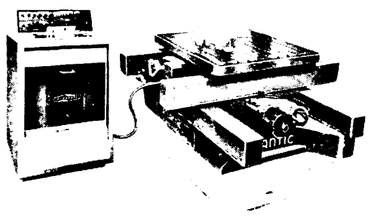
If the amount of advance is reduced, ribbons, of silver sections with very little variation are produced down to settings of 30 mu (somtimes down to 25mu). At settings below this value there is a tendency for sections to be cut alternately thicker and thinner than the amount of advance but it is still possible to cut single sections down to 10 mu.

If a period of 15 minutes or so is allowed for the specimen to reach a temperature equilibrium with the specimen bar after the block and holder have been handled during trimming, the thickness of the sections, according to their interference colours, agrees closely with the amount of advance set (making allowance for the increase in thickness caused by compression during cutting).

The DOWDING-'ATLANTIC' Co-ordinate Table with FERRANTI Electronic Control

IMPROVES ACCURACY

THE ATLANTIC Co-ordinate Table provides a high standard of positioning accuracy. The measuring equipment applied to both X and Y table axes is precise, comprising transmission type diffraction gratings accurate within ±.0002" per foot, co-ordinate dimensions being repeatable within ±.00025". It will be readily appreciated, however, that the final degree of drilling accuracy obtained will to some extent depend upon the accuracy of the machine on which the equipment is mounted.



The Dowding Atlantic Co-ordinate Table with Ferranti Positioning Control.

The measuring system synchronises the table traverses with the instructions recorded on the hand setting dials, or the tape, through a feed back circuit, thus rendering the accuracy of the table setting entirely independent of the leadscrews. Duplicate circuits check the setting, a warning light indicating any disparity and preventing further positioning until the fault is rectified.

The table itself is finished to an equally high standard of accuracy. The leadscrews are hardened and ground, the leadscrew nuts being of the pre-loaded recirculating ball type The table and carriage are likewise mounted on recirculating ball slideways to eliminate sticktion, the slideways being hardened and ground. Assembly is carried out with the aid of an auto-collimator ensuring straightness and squareness of the slideways. The slideways are fully protected by heavy steel covers and plasticised fabric belting, the leadscrews being fully enclosed and protected by wipers.

SIMPLIFES OPERATION

For repetition work, using tape control, the first component is mounted on the ATLANTIC Table with its datum edges parallel with the table axes, suitable locating and clamping arrangements being provided to permit each successive workpiece to be similarly positioned. Any convenient point within the table area can be selected to provide a datum point which can be set for the entire batch of workpieces simply by pressing the 'Datum Set' button, conveniently located on the control console panel. The table will now return to this position automatically on completion of each component.

Pressing the 'Start' button causes comparison circuits to select the traverse necessary to synchronise the initial drilling position with the reading recorded on the punched tape, each of the table leadscrews being rotated by a 3-phase a. c. motor operating through a high speed Warner-type clutch and reduction gearing.

As soon as table position and tape reading coincide, the high speed clutch is disengaged, the power being transferred to a low speed Warner-type clutch which imparts a slow table creep in the reverse direction, cancelling out the initial over-run. On regaining the point of coincidence the drive is again disconnected and the table magnetically clamped, the operator being informed by means of a signal light.

For hand setting, for instance, when drilling one-offs never to be repeated, the required dimensions for each successive table position are set by means of manually operated decade dials, the one set controlling the X and the other the Y co-ordinates.

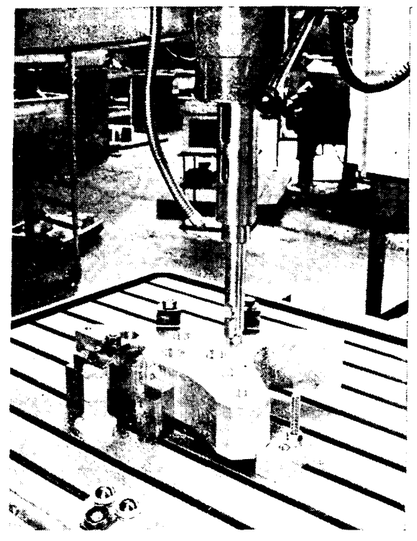
THE CONTROL SYSTEM

FERRANTI Numerical Positioning Control has been selected as standard equipment on ATLANTIC Co-ordinate Tables. The system has been developed especially for arduous workshop conditions. It provides an exceedingly high standard of accuracy *plus fully automatic checking*, its accuracy being totally unaffected by wear.

THE CONTROL DESK

The control desk is mounted at the top of the electrical console, at a convenient working height.

On it are grouped the tape reader, the two rows of decade dials used for manual setting of the X and Y co-ordinates and a two-way switch for selection of manual or tape control; also the 'Datum Set' and 'Start' buttons and 'Clamping' and 'Fault' indicator lamps.



A Typical Accurate Boring job for the Atlantic Co-ordinate Table.

Photo: By Courtesy of the De Havilland Aircraft Co., Ltd.

Control desk panels are available for either English or metric systems of measurement, the English panel having six dials giving a maximum reading of 99.999" with final setting to .00025".

THE TAPE READER

The tape reader accepts standard $\frac{1}{16}$" wide paper tape with 5-hole decimal coding (8-hole tape on special request). Up to 200 feet of tape can be accommodated, providing for 600 complete operational sequences. The reader head can be released for ease of loading and to permit re-spooling.

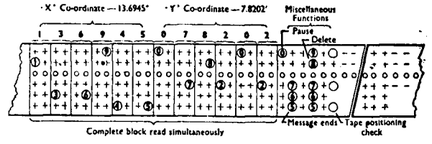
The reading head circuits automatically check the correct positioning of the tape, also checking the contact at each decimal position, an indicator lamp informing the operator in case of faulty loading.

THE ELECTRICAL CONSOLE

The entire electrical equipment, with the exception of the leadscrew driving motors, contactors and relays, is housed within a free-standing console, easily movable on castors.

The printed circuit cards, of which only four different types are used, are provided with edge connections for ease of maintenance and are readily accessible. Signal lamps indicate the faulty channel in the event of failure.

Provision is made at the junction box for a connection to initiate the drilling operation and there is further provision for an interlock switch to be fitted to the drilling head movement in order to start the positioning cycle on completion of each drilling operation.



THE PUNCH UNIT

The keyboard is extremely simple, being provided with keys designated 0 to 9 with an additional space key. The keys operate directly on punch pins located in a hardened platen. Each time a key is depressed the tape is punched in the appropriate position. On releasing the key, the tape is transported to the next position.

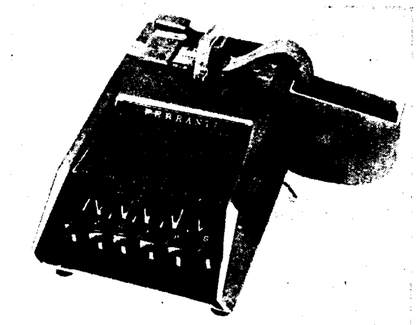
Miscellaneous coding, such as "Message ends' or 'Delete', is recorded by depressing the appropriate figure keys with the space key held down.

Standard $\frac{1}{16}$" paper tape is available with feed sprocket holes pre-punched.

CODING

Code apertures in the first row across the tape represent figures 0 to 4 and in the second row 5 to 9 according to their position relative to the feed sprocket holes, the 6 figures in the 'X' and the 6 in the 'Y' co-ordinates each accounting for 12 spaces.

The complete series of codings for both 'X' and 'Y' co-ordinates is read at at single operation.



The Ferranti Tape Punch

NO MORE EXPENSIVE JIGS MARKING OUT INSPECTION PRODUCTION HOLD-UPS

The DOWDING-'ATLANTIC' Co-ordinate Table has been developed for rapidly and accurately locating the positions of hole centres—automatically—and enabling any drilling layout to be repeated at any future time with equal precision.

The system is electronically operated, and is equally efficient when applied to one-off or batch production. For single workpieces co-ordinate dimensions can be set by decade dials on the control panel, while for batch work centres are electronically programmed by means of punched tape. Any number of centres can be programmed.

Jigs are entirely eliminated, also inspection. No costly toolroom work is entailed, no lengthy and laborious marking out, not on expensive jig boring; and there is no delay in putting the first batch of components into production.

The tape is quickly and easily prepared and the cost negligible. It is convenient to store and, once prepared, embodies complete operational instructions for the most complicated drilling layout ready to be repeated at a moment's notice. Modification can be made to any layout quickly and easily, at the cost of a few pence.

SPEEDS UP PRODUCTION

With the time involved interpreting drawings, marking out and setting entirely eliminated, accurate location of centres on the most complicated drilling layouts becomes purely automatic and operator's time fully productive. Fatigue is greatly reduced and errors totally eliminated.

The table moves directly from one position to the next along both X and Y axes simultaneously at a traverse speed of 60" per minute, an additional 3 seconds being required for final accurate positioning and clamping.

EXPANSION OF INDUSTRIES

Indian industries involving a total outlay of over Rs. 30 crores, have sought the assistance of the Indian Investment Centre, New Delhi, in finding technical and financial partners with firms in Canada, Japan, West Germany, the U.K. and the U.S.

According to a Press release issued by the Investment Centre, Indian firms are seeing partners for the manufacture of wire ropes, water meters, seamless tubes, malleable castings, electric house service meters, galvanised iron pipes and steel tubes. Assistance is also being sought for the production of tyres and tubes cellulose acetate flakes and fibre, insulators and optical instruments. Of the requests forwarded, 19 went to the U.S. ten to the U.K. six to West Germany and one each to Canada and Japan.

CORROSION-RESISTING VALVES

By H. E. Threlfall, B. Sc. (Eng.),
Sales Manager, Langley Alloys Ltd., U. K.

Compatibility of materials, crevice corrosion and galvanic corrosion all pose problems for the design engineers—Editor

THE term ' corrosion-resisting ' is normally taken to mean valves employed for handling corrosive chemical products or intermediates rather than water, steam and similar duties. Further, with the more widespread use of stainless steel and special alloy valves the term is sometimes applied to these valves to the exclusion of valves in iron, steel or bronzes, which should, of course, be included.

CONSTRUCTION MATERIALS

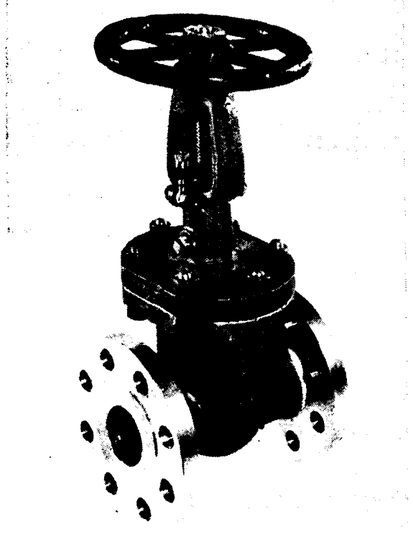
The material of construction is the pivot point of the valve application since it will be dictated or restricted by the corrosive to be handled and will in turn impose limitations on valve design and, possibly, operation Materials commonly available are :

(1) Cast iron
(2) Cast steel
(3) Lead and alloys of lead
(4) Bronzes
(5) Stainless steels
(6) Special alloys

Cast iron is very widely employed for handling waters of all kinds, caustic solutions and concentrated sulphuric acid. Special irons also are used for improved life on caustic liquors and silicon irons (containing 14% Si) are used for a wide range of sulphuric acid concentrations and temperatures. Lead and lead/antimony valves are also frequently used with sulphuric acid and possess the particular features of ease of repair and relatively good scrap value. The uses of cast steel are generally limited to more mildly corrosive conditions but where mixtures with petroleum oils are involved the inhibiting effect of the hydrocarbons on the attack by the corrosive may often be most marked and will allow the use of this relatively inexpensive material.

Bronzes are employed on many duties for corrosive waters, acids and alkalis and frequently offer outstanding service on sulphuric acid duties. The alloys used are usually true bronzes of copper and tin (sometimes referred to in this context as acid-resisting bronze) or aluminium bronzes, but it must be emphasized that many so-called ' bronze ' valves are in fact made of gunmetals and the corrosion resistance of such valves may be disappointing because of the selective corrosion attack on the zinc content of the alloy.

Stainless steels are, of course, now widely used and will handle very many salt, caustic and acid solutions. The most notable application of the standard 18% Cr-8% Ni type of stainless is with nitric acid. An addition of about 3% molybdenum to such an alloy



Corrosion-resisting valves of Langley Alloys Ltd., Slough, Bucks

modifies the corrosion resistance, for example, by improving resistance to pitting on alkaline duties and increasing to some extent the very limited resistance of the simpler alloy to sulphuric aeid. It should however be stressed that the addition of molybdenum does not necessarily make the alloy ' better ' (in fact with some nitric acid conditions, for example, it could be worse but merely different.

On many duties the particular feature of stainless steel will be not merely the life of the valve but also the relatively low possibility of contamination of the fluid handled by corrosion products. Where this is desirable the use of iron or steel may be ruled out although the actual valve life may be quite satisfactorily economic.

SPECIAL ALLOYS

Of the special alloys which can be used in valve manufacture most of these at the present time tend to be either higher alloys of the stainless steel type (that is to say they will contain probably more than 18% Cr, 8% Ni, and 3% Mo but will still have a substantial iron content) or nickel base alloys. Of the high alloy stainless steels, the alloy known widely in the USA as ' 20 Alloy ' is now finding increasing application on this side of the Atlantic. The nominal composition is 29% Ni, 20% Cr, 4% Mo, 4% Cu, balance iron with controlled carbon contents. Trade for alloys of this type include Durimet 20, Langalloy 20V, and Aloyco 20 and they all possess excellent resistance to sulphuric acid over a wide range of conditions. On many other duties such as phosphoric acide and acetic acid they offer improved corrosion resistance as compared with the standard 18/8/3% Mo types of stainless steel. Coupled with this is the fact that finished valves in 20 alloy are only about 15% more expensive than valve in the standard type of alloy.

As a result valves and pumps as critical components in the system are quite frequently made of this alloy although the vessels and piping may be of the standard 18/8/3% Mo type of alloy.

Perhaps the most well-known nickel alloy is Monel which contains approximately 70% Ni and 30% Cu. It has excellent resistance to many waters, salt solutions and caustic liquors as well as to many milder acid solutions. Other nickel alloys include alloys containing molybdenum, chromium and perhaps a few percent of copper and these are generally characterized by good resistance to sulphuric acid and almost all salt and caustic solutions. Some are also resistant to oxidizing conditions and to nitric acid (usually those with 15% or more of chromium) and one type which is basically an alloy of nickel and 30% of molybdenum is highly resistant to many hydrochloric acid conditions for which most other metals and alloys are usually unsuitable. Pure nickel also is sometimes employed, usually for considerations of purity and freedom of contamination of the fluid.

PLASTICS AND RARE METALS

Mention should also be made of metals such as tantalum and titanium which are sometimes used for valves for specific conditions but up to the present the high cost of such metals and the difficulties of valve manufacture have made the finished valves very costly and not of very likely general use. Plastics of many varieties also are now extensively used for valves but must be considered separately due to entirely different mechanical and physical properties and methods of manufacture. The use of plastics for items such as gland packings and gaskets however should be considered and one of the most used of these is polytetrafluoroethylene sold usually under the registered trade names of Fluon or Teflon. In recent years the use of this material either alone or with asbestos has increased enormously and has solved many problems. Where it is used alone as a gland packing the surface finish of the valve stem is particularly important for best results, as is a fairly close tolerance on stuffing box diameter.

This material, p.t.f.e., is also now often employed as one half of a valve sealing element, either as the disk or seat facing, since it is inert to almost all conditions and will flow to take up irregularities due to wear or corrosion in the mating part. However it must be restrained in some measure because its tendency to flow must be limited in order to avoid the need for constant re-tightening.

TYPICAL VALVE DESIGNS

All the normally well-known designs are used for corrosion services and the service life obtained must necessarily depend on the specific service conditions and the material of construction. There are, however, a number of general features of each type of valve and these are given in Table I for ease of reference. The typical valves referred to are arranged in three groups roughly according to the method of sealing of the valves. This is not a strictly definable method of grouping but serves some purpose in helping to com-

TABLE 1

FEATURES OF VARIOUS TYPES OF VALVES

Valve Type	*Features and Advantages*	*Disadvantages*
GROUP 1 RING-SEALING VALVES		
Globe	Regulating characteristics. Well known principle for ease of maintenance.	Turbulent flow. Resistance to flow.
Y-Type	Screw-down seating arrangement. Fairly low resistance to flow.	Remote manual control difficult.
Gate	Sliding action in closing cleans seats. Pressure tends to hold valve closed tight.	More difficult maintenance.
GROUP 2 AREA-SEALING VALVES		
Plug	Quick open/close. Large tolerance for corrosion before leakage.	Sticking, wear, consequent leakage.
Lubricated Plug	Quick open/close. Large tolerance for corrosion before leakage.	Contamination from lubricant. Need for regular attention.
Sleeved Plug (Sleeve p.t.f.e. or other)	Quick open/close. Large tolerance for corrosion before large. ' Self-lubricating '.	Temperature and pressure limits on sleeve.
GROUP 3 LINE-SEALING VALVES		
Diaphragm	Simplicity. Limited use of corrosion resisting alloy needed.	Temperature and pressure limits on diaphragm. Fatigue of diaphragm.
' Pinch ' Type	Extreme simplicity. Usually no metal parts in contact with corrosive. Good for slurries.	Temperature and pressure limits on sleeve. Fatigue of sleeve.

pare the broader classifications first, and then the individual types within the groups.

Reference should be made to the ' pinch ' valve since although it might not be expected to form a part of this survey it is widely used especially for corrosive slurries at normal temperatures and because of its relatively low cost should not be overlooked.

EFFECT OF MATERIAL ON DESIGN

Most bronzes, cast steel, and stainless steels have average mechanical properties and do not therefore impose serious limits on general mechanical design. Cast iron is known to have lower elongation and therefore this must be allowed for. Silicon iron is usually especially brittle and shocks of any kind must be avoided. Lead is on the other hand, ductile and liable to ' creep ' at not very high temperatures especially where there are temperature change cycles.

Some of the special alloys, Monel for example, again have average mechanical properties but others may be brittle, hard, tough or otherwise difficult to handle in manufacture, installation or maintenance.

A problem feature of stainless steels and many other alloys is their bad running properties when in contact with the same or similar materials. This can cause premature leakage of the valve due to resultant ' pick-up ' between the metal sealing faces. Very careful attention to design of the sealing elements is necessary to overcome this since it is rarely possible to choose two dissimilar metals for their good bearing properties on each other by reason of the corrosive conditions. This is one of the reasons for the use of a non-metal for one of the sealing elements as already mentioned above in the case of p.t.f.e. for such a duty. There are many cases of high temperature, however, where such a solution is not possible.

TABLE 2

RELATIVE ELECTROLYTIC POTENTIALS OF SOME MATERIALS

' Noble ' or protected end
Platinum
Gold
Graphite
Silver
Austenitic stainless steels
Langalloy 20V—Carpenter 20, etc.
Langalloy 7R—Illium C
Langalloy 5R—Hastelloy alloy G
Chromium-Iron
Inconel
Nickel
Monel
Copper-Nickel Alloys
Hidurax 1
Bronzes
Copper
Langalloy 4R—Hastelloy alloy B
Tin
Lead
Cast Iron
Steel and Iron
Cadmium
Aluminium
Zinc
Magnesium
' Base ' or corroded end

Metals and alloys shown bracketed together can be grouped as being of virtually the same electrolytic potential and therefore can usually be used in conjunction, without the danger of electrolytic corrosion arising.

TABLE 3

SAFE COMBINATIONS OF ALLOY MATERIALS IN VALVE ASSEMBLIES

Main body material	*Safe alloy, for different ' trims ' (seat, disk or stem)*
Austenitic Stainless Steel of 18/8 Type	Langalloy 20V Langalloy 5R Langalloy 7R
Langalloy 20V	Langalloy 5R Langalloy 7R
Monel	Langalloy 4R
Langalloy 4 R	Langalloy 6R (Nickel/Silicon)

In most cases a separate different ' trim ' material will be chosen allowing the choice of a less costly alloy for the main body parts. In the case of the Langalloy 4R/6R combination, the choice is to permit the use of Langalloy 6R in those special cases where necessary for its particular resistance to corrosion without the difficulties of making the whole valve in this rather hard, difficult to-handle alloy.

CREVICE CORROSION

Many of these materials, especially the stainless and other alloys containing chromium have a particular feature of susceptibility to ' crevice corrosion '. The phenomenon is displayed in a crack, pit or crevice when the material is in contact with a corrosive to which it is generally highly resistant. Extremely high rates of corrosion may be experienced in the crevice area only whilst the rest of the material is virtually unaffected. For this reason separate or renewable seats in valves made of stainless steel and most other alloys are not recommended as good general practice. Rapid crevice corrosion can cause leakage between seat and body and in many cases the seat becomes completely detached from the body and the body is too severely corroded for repair to be possible.

COMBINATION OF MATERIALS

For economy reasons it is often desired to use a more resistant material for the valve trim (seat, disk and stem) and a less expensive material for the main body parts where there is more tolerance for corrosion before failure. This is frequently possible and in fact

s very commonly done in cast iron or cast steel valves. In the case of the stainless steels and special alloys there tend to be more pitfalls for the unwary and it is useful to refer to the two major difficulties.

The one is crevice corrosion already mentioned. It is desirable to determine if this may be a factor if the separate seating is employed. The other is the possibility of electrolytic (or galvanic) corrosion taking place between the two materials used. For this to occur the liquid handled must be an electrolyte. Usually dilute solutions of salts or acids are stronger electrolytes than concentrated solutions. If such liquids are handled the two materials of the high construction of the valve must have also almost the some potential in the electrochemical table (see Tables 2 and 3). Where the two materials both offer reasonable resistance to similar kinds of conditions e.g. strongly oxidizing or strongly reducing, this is often the case but it is by no means certain, so that investigation is advisable to avoid what can sometimes be a most accelerated failure.

There is a third problem which sometimes arises in the use of trimmed valves and which also is not infrequently encountered when the pipes and valves are of different metallic materials. This is due to corrosion attack on one material by the corrosion products from the other, when these products are soluble in the liquid being handled. It is not possible to lay down any simple rules for avoiding this problem and the only suggestion is to consider the various materials in the system, the likely corrosion products resulting, and their possible effects on any part. When such corrosion does occur it may be confused with electrolytic corrosion because of the preferential nature of the attack. However, a study of the relative electrolytic potentials of the corroded and unaffected parts will help in establishing the true position. If a small area of more noble material is attacked then it is not the result of electrolytic corrosion. (Courtesy: "Nuclear Power")

AEI Participating in the Skybolt Programme

SOME details can now be given of work involved in adapting the American Skybolt air-to-surface missile to this country's V-bombers, and of the highly-developed electronic devices which make the bombers into precise flying systems.

It was in April 1960 that the Minister of Defence announced that the United Kingdom was negotiating for the purchase of the American Skybolt air-to-surface Missile for R. A. F. bomber command in place of the cancelled Blue Streak. Information has since been released that arrangements are well advanced for installing Skybolt on the Avro Vulcan D. 2. bomber and that British firms will play a major part in the aircraft modification programme.

A. V. Ree Limited, manufacturer of the Vulcan, has been given the responsibility for modifying the airfame to accommodate the missile. Associated Electrical Industries Ltd. has been given the task of specifying the modifications necessary in the existing navigation system of suit Skybolt, and of the development and manufacture of the fully transistorised conversion equipment for linking the existing system with that of the missile. This is being carried out by AEI's Electronic Apparatus Division which has extensive knowledge and experience in the development of the present V-bomber navigation and bombing computer system.

The missile guidance system works in digital language and it is the function of the new AEI conversion unit to transform navigational information from its original analogue form into the required digital form without loss of accuracy.

Techniques used in the construction of the conversion unit will be consistent with those employed in the Skybolt equipment. Special test gear for the unit will also be manufactured and technical assistance will be provided by AEI during the proving trials of the weapon system.

V—BOMBERS CONTROLLED BY COMPUTERS

Computers made by Associated Electrical Industries Limited form the brain centre of machines which, while still carrying pilot and navigator, have electronic means both for controlling flight and delivering weapons.

Many years of planning and research led to the evolution of the modern bomber capable of carrying nuclear weapons. Before the last war ended it was realised that the jet engine would so raise the speed and operating altitude of the bomber as to make it impossible to control by human means to achieve its proper role. Replacement of the human bomb aimer by a mechanism that could respond quickly and accurately without tiring necessitated the use of computers to carry out all the intricate calculations for determining the position, steering the aircraft, and predicting the release point for the bomb missile. Exploratory designs were started at the end of the war and eventually the Navigation and Bombing Computer went into service.

The development of this project was undertaken by the Rugby Group of Associated Electrical Industries Limited (then the British Thomson-Houston Company) in close co-operation with the Royal Radar Establishment at Malvern and the Royal Aircraft Establishment at Farnborough. AEI acted as main contractor, work on some units being sub-contracted to AEI-Hotpoint at Peterborough, Ericsson Telephones Limited and Murphy Radio Limited.

TRAINING IN NEW TECHNIQUES

In introducing into service the novel ideas associated with this now computing equipment, the R. A. F. faced a formidable task. The operational side was simplified as far as possible by proper design of the controls, and special trainers were developed which enabled aircrews to be trained on the ground in the art of navigation and bombing using simulated displays.

Maintenance of the equipment required new departures in organisation and training, and led to the establishment of specially equipped and staffed "electronics centres".

The R. A. F. also made extensive use of field organisations staffed by civilian engineers. These have had the dual function of assisting in the investigation of the more obscure difficulties which can arise in a new and complex equipment and also of acting as the designer's representatives, reporting back matters of interest or which require modification action. This direct link has undoubtedly paid dividends in smoothing the path of the R. A. F. in its technical advancement, and of the manufacturers in giving efficient service.

Recent Developments in Arc Welding Equipment

By An Engineering Correspondent

LINCOLN Electric Co. Ltd. now part of the Guest Keen and Nettlefolds Organization, were pioneers in the development of arc welding plant and electrodes. Starting from a small factory in Broadwater Road, Welwyn Garden City in 1935, the company expanded rapidly, taking over an adjoining factory in 1937 and further adjacent premises in 1949.

In 1957 Lincoln Electric Co. Ltd., by now the largest manufacturers of D. C. Welders in the United Kingdom, moved to their new factory of some 11 acres on the North East Industrial Estate, Welwyn Garden City, from which the full range of Lincoln D. C. Welding Machines, Automatic Welding Units, Electrodes and Accessories are supplied to most countries of the world.

Since the Company's inception it has been a fundamental of their policy to continuously undertake a broad programme of research and development to ensure that their products incorporate the most up-to-date features and efficiency of performance required by modern industry, and amongst the developments which they have introduced in the past few years may be mentioned the following :—

ELECTRODES

Lincoln Electric Co. Ltd. provide a complete range of manual electrodes for the welding of mild steel, special steels, cast iron and hardsurfacing.

Recent important advances include the introduction of NuSeven an iron powder-rutile type electrode for general application to the welding of mild steel in all positions. Particular advantages over conventional titania (E. 317) type electrodes include :—

* higher deposition efficiency ;
* faster deposition rate (10–30% greater);
* less sticking of the electrode.

NuSeven electrode may be manipulated to either reduce the number of passes on a multi-run joint, or to give increased length of single beads.

Up to 30% more weld per electrode is obtainable, thus giving more arc time.

NuMang XL electrode is of the basic coated low hydrogen type, depositing austenitic manganese steel of 14% manganese and 3½% nickel composition.

The main application is for the build-up of manganese steel to high carbon steel parts, but it is also suitable for joining manganese steel or manganese steel to high carbon steel combining high resistance to severe impact with good wear resistance.

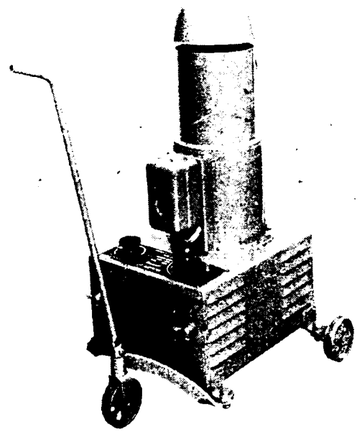
NuMang XL is specially suitable for the re-surfacing and surface build-up of a wide range of machinery in the quarrying, earth moving, railway equipment, mineral and ore crushing industries.

In addition to the new arc welding electrodes mentioned above, Lincoln Electric Co. Ltd. have recently introduced, after considerable research, a new type of welding rod which offers great advantages in the field of oxy-acetylene welding brazing. This is the L. E. C. O. Flux Coated Low Fume Bronze Welding Rod, which has already proved considerably more economical than the bare bronze wires generally used with a fluxing agent. It is widely employed in car body shops, for the production welding of bicycle frames, and for the repair of cast iron and other maintenance applications.

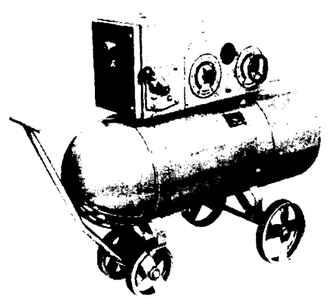
D. C. WELDING MACHINES

Lincoln Electric Co. Ltd. are the acknowledged leaders in this field and provide an unrivalled range of both motor and engine driven sets.

In the field of motor generators the smallest machine, the SA 150 provides a current range of 30 — 200 amperes, whilst the largest the SAE 900, is widely used either singly or in parallel, as a power source for automatic welding. Recent introductions specifically designed to meet the requirements of automatic welding are the Arcmaker CV. 400 and CV. 750 Motor Generators providing constant potential welding current with a continuous output of 400 and 750 amps respectively at 40 volts. Constant potential welding is particularly advantageous where burn through is a



The Arcmaker SA. 150 Motor Generator.

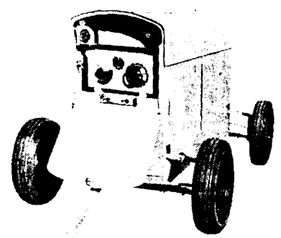


The Arcmaker type C.V. 400 Constant Voltage Motor Generator fitted with Variable Stabilizer.

problem and for welding light gauge materials. The CV. 400 is ideally suited for use with the C02 Welding Process.

Lincoln Electric Co. Ltd. Engine Driven Welders, are used on the majority of pipeline and field welding projects throughout the world, and include both petroleum and diesel driven types, with current ranges extending from 30–200 amperes (SA. 150) to 80–500 amp (SAE 400). Machines can be provided from stock close coupled to Ford, Perkins, Dorman, Ruston-Hornsby and Armstrong Siddeley Engines.

Amongst new additions to the Lincoln Engine Driven range may be noted the Perkins Four 270 powered SAE 300 Diesel Engine Driven Welder, and the Ruston Hornsby powered SA 200 Air-Cooled Engine Driven machine. Both these engines are specially designed for efficient operation under the most strenuous climatic conditions.



The Arcmaker SAE. 300 Mobile Welder powered by the Perkins Industrial Diesel Engine.

Quite distinct from the motor driven D. C. Generators is the latest Lincoln welding power source, the Arcmaker Silicon Rectifier Transformer. This type of unit has been produced in the United States of America for some years, but the new Lincoln Arcmaker Unit is believed to be the first of its type to incorporate Silicon rectifier diodes. Silicon diodes are an important advancement in that they have a longer life and provide smoother operating characteristics. D. C. Current of the type provided by the Arcmaker Rectifier Transformer is especially suitable for use with low hydrogen and low chrome alloy electrodes.

THE ARCAIR TORCH

Originally developed some 10 years ago primarily for removing stainless steel welds from Naval armour, the Arcair Torch has since become an indispensable tool in foundry, maintenance and fabrication shops all over the world, making possible time and money savings of up to 80% of Gouging and Cutting. Simple to operate, the Arcair Torch uses an ordinary D. C. Welding Machine and Compressed Air. It will groove, cut, gouge or bevel almost any metal by melting it with an electric arc and then blowing away the melted metal with a continuous jet of compressed air, constantly directed at the point of arc. The arc is maintained between the work and the carbon graphite electrode, held in the Torch, which directs the air and controls its flow. The Torch can be used in any position and the air jet is always aligned with the point of arc, automatically and regardless of its position!

Current supplied by D. C. Welding Machine and ordinary Compressed Air at 80 - 100 lbs. per square inch are used, both brought through a concentric cable which is supplied with the Torch.

The Torch features a push-button operated air control valve, self-aligning rotating jet permitting adjustment of the carbon to any angle, and air-cooling for the comfort of the operator. The Arcair process is much faster than grinding or chipping, and operation cost is lower than with these or other methods.

The Arcair Torch is available in two models. Model H.3. (10⅜") (26.6 cms) long) is specified for light duty and uses Arcair Copper-Coated Carbons up to and including 3/8" diameter long. The H.5. Model (12⅞") (32.7 cms.) long) is specified for heavier duty and accommodates Arcair Copper-Coated Carbons up to and including 5/8" diameter.

AUTOMATIC WELDING

Lincoln Electric Co. Ltd. have for many years pioneered the way in Submerged Arc Welding Equipment and their Fully Automatic Welding Heads are widely used in the Nuclear Field, in the manufacture of pressure vessels, and in all branches of general Industry. The important part played by automatic welding in the Nuclear Power field is of particular interest for it has been extremely valuable in meeting the very high standard of welding quality demanded by this new industry, also enabling fabrication times to be considerably reduced compared with other methods due to the exceptional welding speeds obtainable with the SUBMERGED Process.

A brief description of the latest Submergarc Submerged Arc Welding Equipment, Wires and Fluxes, is given below :—

ELECTRODE WIRES & FLUXES

Lincoln Electric Company Limited are the only company in the world able to offer all types of fused and unfused fluxes for the welding of mild steel to Class 1 requirements *plus* a comprehensive range of special fluxes and electrode wires for the Submerged Arc Welding of the following groups of steels :—

(1) 12% to 14% Chromium Stainless Iron.

(2) 18/8 Austenitic Steels, including niobium bearing and molybdenum bearing.

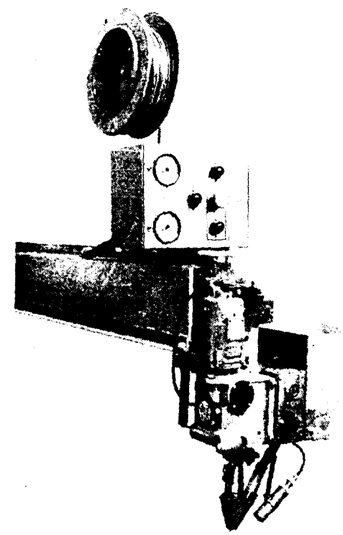
(3) Molybdenum bearing and chrome molybdenum creep resisting steels.

All these fluxes are British made at the Lincoln factory at Welwyn Garden City.

TYPE B.10 FULLY AUTOMATIC SUBMERGED ARC WELDING HEAD

This unit consists of a stationary fully automatic submerged arc welding head which can be mounted on a movable column and boom, suitable for both the external and internal welding of vessels and pipes of all sizes, thicknesses and diameters.

All types of fabrication in every shape and size can be welded with the Submerged Arc B. 10. Unit as



The Submergarc type B. 10 Fully Automatic Welding Head mounted on the end of a travelling beam

the head is designed to give localised horizontal movement in all directions and vertical life between 6" as required. The head can also be positioned to meet a wide range of angle requirements and there is a choice of jaws with extension pieces where needed. Both fillet and lap welds can be carried out with the unit in addition to conventional " Down-hand ".

The machine is simple in construction and is designed to take care of variable welding conditions through the wire feed motor, which is controlled by the arc voltage thus ensuring a stable arc length. A guide light is also provided so that the operator can at all times follow the track of the wire—an essential where high quality welding production is required. Amongst the additional features of the type B.10 Submerged Arc Welding Hend are a polarity switch, dust proof easy-to-read meters and immediate " contact starting " by merely inching the electrode on to the plate. This contact start is an original Lincoln Electric Co. Ltd. feature eliminating the use of a fuse such as wire wool.

All sizes of wire from 3/32" to 7/32" can be employed without changing gears or jaws, and the process can be used for a wide variety of metals, both mild steel and alloy materials. The B.10. can be adapted for " Twin-Arc " operation with a minimum of adjustment.

TYPE B.11 FULLY AUTOMATIC SUBMERGED ARC WELDING HEAD

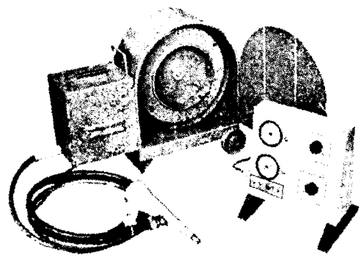
The type B.11 Fully Automatic Submerged Arc Welding Head is similar in every way to the B.10 Unit described above, with the addition that the head is mounted on a self-propelled travel carriage which will travel within a wide speed range along a fixed beam.

TYPE C.10 SELF-PROPELLED TRACTOR WELDING UNIT

The C.10 machine contains most of the features provided in the B.10 and B.11. Units, but is designed to travel on flat surfaces under its own power. The Submerged Arc Tractor Welding Unit does not require a " track " and all controls travel with the machine. It is particularly suitable for use on such applications as the welding of ships deck plates and storage tank bottoms.

TYPES M. L. 2 AND M. L. 3. SEMI-AUTOMATIC SUBMERGED ARC WELDERS

The M. L. 2 Submerged Arc Welding Unit, although designed for operation by hand, can be readily mounted on a travel carriage and turned into a Fully Automatic Unit if desired.

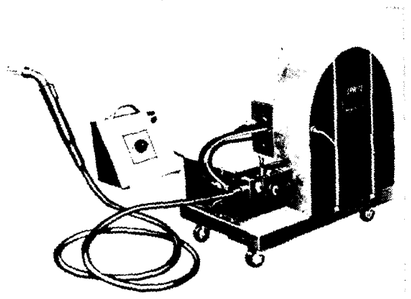


The Manual Submergarc M.L.3. Remote Control Semi-Automatic Submerged Arc Welding Unit

The M. L. 3 is similar to the M. L. 2. Machine but is provided with a Remote Control Unit enabling the operator to regulate the current and voltage settings at the actual point of welding.

THE ARCMAKER SPRITE FINE-WIRE C02 WELDING UNIT

The new Arcmaker SPRITE C02 Welding Process, developed by Lincoln Electric Company Limited



The new Arcmaker SPRITE C02 Gas Shielded Arc Welding Unit showing the separate Remote Control Box and the FW1 C02 Hand Welding Gun

Engineer, is designed to bring a new era of efficiency and economy to the production welding of mild steel fabrications. SPRITE C02 Welding, which is specially suited to the requirements of light gauge sheet metal fabricators in the automobile and allied industries and the fabricators of light mild steel plate work and light gauge metal components, is simple to operate, versatile and much faster than older methods of manual welding.

The type FW1 Hand Welding Gun used with the SPRITE C02 Welding Unit will weld in all positions down to 20g. sheet, even where poor fit-up is experienced, with minimum distortion, producing almost spatter-free welds to Lloyds Standard without flux or other weld covering.

In addition to the SPRITE C02 Welding Unit, which incorporates an infinitely variable wire drive unit capable of driving wire of 1/32" (0.78 mm) and 3/64" (1.2 mm) in diameter at speeds of from 130—300 in/min. (330/762 cms/min,), the complete equipment includes the Arcmaker type FW1 Hand Welding Gun, a Remote Amperes Control Box with C02 Gas Purge Operating Button and the Arcmaker Type CV.400 Constant Voltage Motor Generator providing 400 amps. continuously at 40 arc volts for 100% duty cycle and fitted with a Variable Stabilizer enabling the correct value of inductance to be utilised, thus increasing the welding range.

The Arcmaker Type FW1 Hand Welding Gun is specially angled to give easy manipulation during operation in any position, and is attached to the SPRITE Wire Feed Unit by *one* specially designed lightweight cable incorporating all connections to the gun (wire, gas and current) giving maximum flexibility during operation.

The foregoing is of necessity only a brief survey of some of the recent developments introduced by the company, and a number of other new electrodes and processes are coming into production or undergoing proving trials. It is this constant impetus of new equipment, new materials, new techniques, which, backed by a specially trained and highly skilled engineering staff with the experience of many years and many hundreds of installations throughout the world ensures for Lincoln Electric Co. Ltd. the high standing of which the company are justly proud.

India and U.S. Sign Loan Agreements for Power Projects

The Governments of India and of the United States signed agreements covering U.S. loans totalling $62.9 million (Rs. 30.0 crores) for three major power projects which will together generate over 750,000 kilowatts.

These loans are from the U.S. Development Loan Fund to meet the foreign exchange costs of the projects. Local currency (rupee) costs, totalling Rs. 32.3 crores, are intended to be covered by separate agreements for loans from the sale proceeds of agricultural commodities supplies to India under U.S. Public Law 480.

Like other loans given to India by the U.S. Development Loan Fund, today's credits are repayable in rupees. These rupee payments are not earmarked to pay for export of goods from India and will not be a charge against India's balance of payments.

The second stage of the Sharavathy Hydro-electric Project (Mysore State), and two thermal power stations at Talcher (Orissa) and Amlai in Birsinghpur District (Madhya Pradesh) are the undertakings concerned in the agreements.

The agreements were signed by Mr. L. K. Jha, Secretary, Ministry of Finance, Department of Economic Affairs, and U.S. Ambassador John Kenneth Galbraith. Mr. Morarji Desai, Union Minister for Finance, presided over the signing ceremony.

The Sharavathy project is one of the biggest hydro-electric projects in Asia. The second stage of the dam, now under construction, will generate 445,000 kilowatts. U.S. loans helped in financing the partial cost of the first stage which provides for the generation of 180,000 kilowatts. From the standpoint of cost per installed kilowatt, Sharavathy is one of the most economical hydro-electric projects in the world.

The 250,000-kilowatt thermal power station to be established at Talcher will supply urgently needed power to utilise Orissa's vast industrial potential.

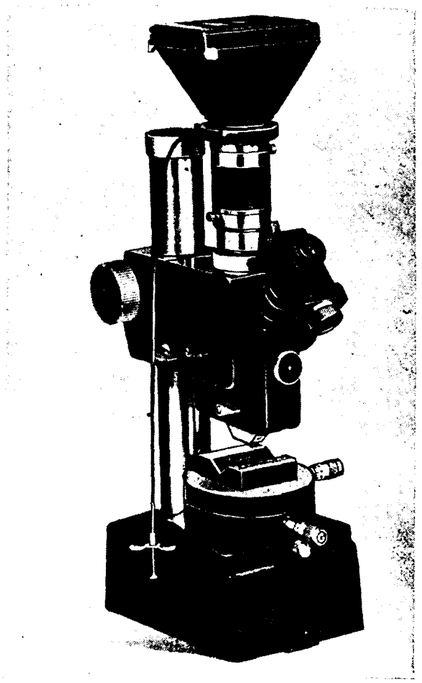
New Types of Precision Instruments from German Democratic Republic

By Dr. Erhard Lippert
VEB Carl Zeiss JENA

LIGHT-SECTIONING TESTER

THE new Light—Sectioning Tester conforms in range of measurement and magnification with the Schmaltz Surface Finish Tester, but has a number of advantages which widen its field of application and facilitate operation.

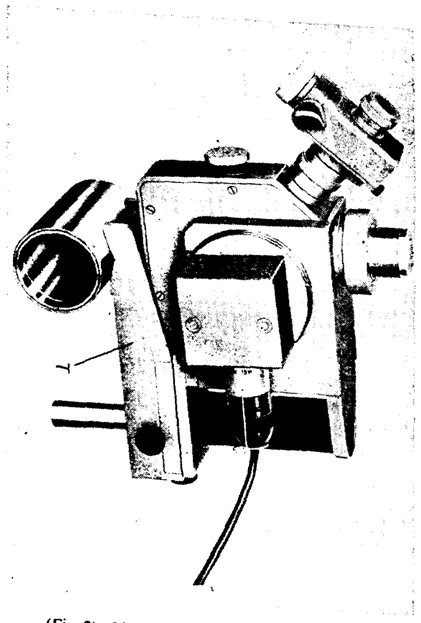
Thus the new instrument can be used as a bench *instrument* (Fig. 1) in the test room and laboratory and as a mobile *instrument* (Fig. 2) placed directly on large workpieces or testpieces still in the machine.



(Fig. 1) Light-Sectioning Tester

The new instrument is of compact design incorporating in addition to the oblique observation tube a straight tube for the MF Photographic Attachment. With its 6 V. 15 W. lamp photographic exposures can be made at shorter exposure than previously possible, the image being observed at the same time.

Special attention was paid to ease of operation : the change in magnification is considerable simplified by both objectives being combined in one *objective block* which can be easily interchanged. This also has *lateral protective* jaws which protest the objectives with high magnification and short working distance from being damaged by unintentionally touching the testpiece.



(Fig. 2) Light-Sectioning Tester (Handgerat)

Working with high magnification is furthermore facilitated by an additional fine motion on the height adjustment. Yet another advantage is the new slit revolver which permits, as required, the production of the profile image with one slit of light or one or several parallel fine lines according to the nature of the nature of the surface. With lower magnifications this permits within certain limits not only the examination of the individual profile section but also the course of the observed unevenness.

Mention should also be made of the new eyepiece micrometer screw with internal reading. When looking into the eyepiece it is not only possible to observe the profile image but simultaneously to read according to the shift of the graduation mark, the measured value, whereby evaluation is substantially facilitated.

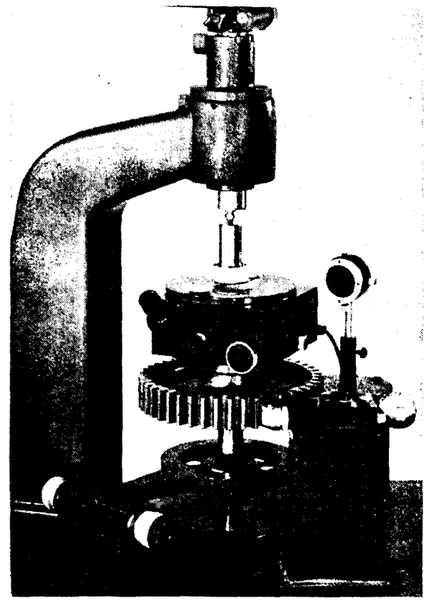
Magnification: 60 ×, 120 ×, 260 ×, 520 ×.

Total range for measurement of depth of roughness: 0.6 to 50 um

for measurement of groove spacing 0.3 to 2.5 mm

ANGLE DIVISION TESTER WITH AUTOCOLLIMATION

The Angle Division Tester is an opto-mechanical precision measuring instrument for angle setting and angle measurement in engineering and precision instrument manufacture. Preferred for a) the manufacture (parts) of graduated plates, circular scales of large diameter (on vertical lathes and facing lathes), toothed gears individual production, b) measuring the circular pitch of toothed gears, graduated scales, dividing heads, rotary stages, angles of polygons, the function of gears incorportated in machines and precision instruments. The mode of operation of the Angle Division Tester (WMG) with autocollimation (AK) resembles that of the optical rotary table, optical dividing head and the JENA theodolite (with collimator). The " WMG " and " AK " differs mainly by the theodolite telescope being replaced by the " AK "—telescope and the collimator by an ' AK "—mirror. Therefore the sensitivity in setting the " WMG " on the graduation mark of the " AK "—telescope is double that obtained when setting the theodolite telescope for the collimator graduation mark. The " WMG " is put on the dividing machine or the testpiece by means of its mounting bush.



(Fig. 3) Angle Division Tester with Autocollimation

The housing of the " WMG " with " AK "—telescope and optical reading system (both fixed to the housing) can be freely rotated after releasing the the stop) relative to the graduated glass scale inside the case but is rigidly connected to the mounting bushes. Because of the coincidence reading of the graduated circle and the parallel path of the rays between the " AK "—telescope and the firmly mounted " AK " mirror, the centering errors of the graduated scale axis to the mounting bush axis and from this to the axis of the machine shaft or test piece are ineffective. When dividing workpieces, set the first dividing step by tilting the " AK "—telescope aligned to the " AK "—mirror through the required dividing angle and by subsequent turning of the workpiece (and graduated glass scale connected with it) by means of a dividing gear on the machine, until the " AK "—telescope is re-aligned on to the " AK "—mirror. Accuracy of the " WMG " in this instance is ± 3″. For measuring circle graduations a swingout precision indicator stop is required (accessory of the " WMG ") and frequently a follower with precision setting. Circular pitch measuremcnts of toothed gears (with mandrel) can be carried out on the well-known JENA Gear Testing

The Generators at Stornorrfors - A New Asea Record

By Carl Lindström
Erection Department, Västeras — Sweden

Three of the world's largest waterwheel-driven generators, manufactured by Asea, were commissioned during the period August, 1958 to May, 1959, at the Stornorrfors Power-station belonging to the Swedish State Power Board. Some general facts are given in the article about the generators as well as a brief description of the delivery, erection work and commissioning.

In various connections it has been stated that the Stornorrfors power project has constituted a record. The tunnel workers have, for instance, blasted 2,600,000 m³ (3,400,000 cu. yards) of rock and in doing this, created the world's largest tunnel, 16 m (52 ft.) wide, 26.5 m (87 ft.) high and 3,950 m (12,960 ft.) long, and the bulldozers and excavators have moved 2,450,000 m³ (3 200,000 cu. yards) of earth—only to mention a few examples.

A considerable part of this giant project is taken up by the power-station itself—an underground chamber blasted out of the rock with the dimensions of a cathedral, 74 m (243 ft.) long, 17 m (56 ft.) wide and 25 m (82 ft.) high along the greater part of its length. This underground building houses the generators, which are the main subject of this article and are, in themselves, of record size. These machines constitute at present, with regard to output, the largest water-wheel-driven generators in the world.

Asea have also supplied to Stornorrfors Power-station with the 380 kV transformers, control equipment and the major part of the switchgear. This part of the equipment will be described in coming numbers of the Asea Journal. The design of the generators will also be treated in a later article. For this reason, only some general data concerning the generators will be given, and the rest of the article will describe the transport, erection and commissioning of the generators.

STORNORRFORS, ITS SITE AND MAIN DATA

Stornorrfors is situated on the southern bank of the river Ume, about 12 km (7.5 miles) to the west of the town of Umea. Here the combined flow of the rivers Ume and Vindel is diverted into the power-station, which, at its present state of development, contains three sets. At a later stage a fourth set will be installed and it is estimated that the combined output will then be 500 MW.

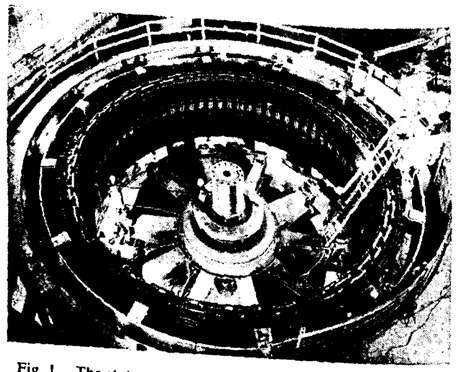


Fig. 1. The stator bearing bracket, combined thrust and guide bearing and shaft ready to receive the rotor. At the end of the bearing-bracket arms the brake blocks can be seen. The latter are utilised, after having been fitted with brake pads, for both braking the rotating parts of the set and lifting these when inspecting, for example, the thrust bearing. (52178. Photographed by Ekholtz)

At the rated load, each set requires 200 m³ (7,063 cu. ft.) of water per second at a head of 75 m (246 ft.). The world's largest turbines, which are of Francis type and manufactured by Nohab, Trollhattan, then supply each generator with 200,000 h.p.

Generators

The generators are of the vertical type and are designed for 150 MVA, P.F. = 0.9, 18 kV, 50 c/s and 125 r.p.m. They are thus considerably larger than the Harspranget generators with a rating of 105 MVA at 167 r.p.m., delivered by Asea in 1951—52. They are, however, of basically the same design as these with a

combined thrust and guide bearing below the rotor and an upper guide bearing.

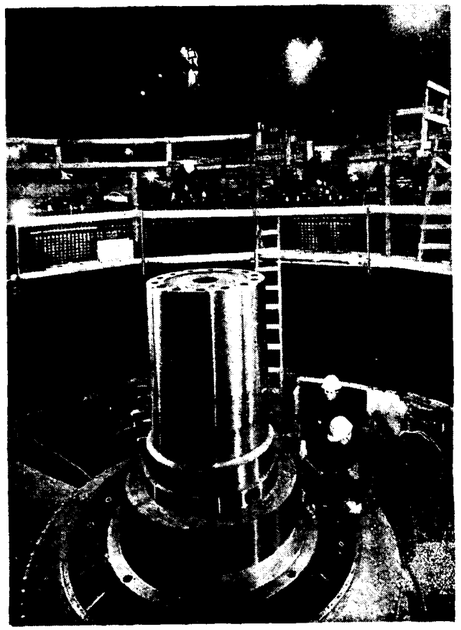


Fig. 2. The lower guide bearing of the generator during the final stages of erection. In the background, the stator winding is being connected at one of the six joints of the stator. (52182. Photographed by Ekholtz)

The illustration on the cover depicts one of the stators in the workshop after the stator core has been stacked in the stator frame. The photograh shows a a special test being made for checking the iron losses of the stator core. The object of this core-loss test is to check the insulation between the laminations in the stator core to see whether it is satisfactory. Current is led through the cables which are shown wound around the stator. Any faults in the insulation of the stator core are revealed rapidly by the resultant magnetic field due to local heating at the site of the fault.

It may also be mentioned that the outer diameter of the stator is 12.1 m (39.7 ft.) and that the height of the stator frame is 3.2 m (10.5 ft.). The pole pieces lying in front of the stator belong to the same generator.

DATES OF DELIVERY

The assembly of the rotor segments was carried out in the machine hall of the power-station. This work was commenced on the first generator in March, 1958. The delivery of the other generator parts took place during the months of April and May, 1958. Thanks to favourable delivery conditions and accelerated erection work, it was possible to carry out the first test run on this generator on August 31st. After six days of testing the generator was ready to be synchronised to the 380 kV system and put under load.

Generator No. 2 was started for the first time on the 11th December, 1958. The tests were completed by December 14th, and the generator then began to supply power to the grid. The main tests performed during this initial test run are briefly described at the end of this article.

The erection of generator No. 3 was terminated by the beginning of May of this year, and the set was connected to the grid in the middle of May.

TRANSPORT FROM THE WORKSHOP TO THE SITE OF ERECTION

All the heavier generator parts were transported by means of special railway trucks to Vannas station, 25 km (15.5 miles) from Stornorrfors. In many cases the dimensions exceeded the values permitted by the normal loading gauges laid down by the Swedish State Railways. The railway trucks were therefore moved with great care in special trains.

In order to facilitate transport from the workshop to the site of erection, it was necessary to design the generators with regard to the transport facilities. The stators were thus divided into six parts, each weighing 44 tons. The rotor spiders, the diameter of which exceeds 8 m (26 ft.), were divided into four sections, each weighing 22 tons.

A bridge crane was available at Vannas station for unloading the generator parts and moving them on to a special trailer belonging to the State Power Board, with a maximum capacity of 225 tons, down by a lorry of imposing size.

Under normal weather conditions the experienced personnel of the State Power Board can carry out such heavy transport work without any difficulty. On the other hand, when, as was the case with generator No. 3, the transportation had to be done in January,

1959, temperatures of below −30°C (−22°F) were experienced and the narrow country roads were covered with snow. Furthermore, the 700 m (2,300 ft.) slope into the power-station (gradient 1 in 7) was covered in ice, which made the work both dangerous and difficult. Everything, however, went off successfully.

Nevertheless, the 380 kV transformers from the Asea Ludvika Works constituted the heaviest load down into the power-station. These each weigh 180 tons, to which should be added the weight of the trailer, 80 tons. The transportation of the transformers took place, however, under favourable conditions.

ERECTION

The erection of the generators was carried out in the same way for all three sets. The actual erection work itself commenced by turning the stator parts, which were transported lying down, and lowering these into their site in the generator pit. After the stator sections had been bolted together, the coils spanning the joints between the stator sections were inserted (Fig. 2).

These coils were then tested with 68 kV, direct voltage, for 60 seconds.

The tests proceeded without any complications. The joining of the winding and insulation of the joints could then be commenced immediately after the bearing bracket had been placed in position in the generator pit. The bracket with its 10 arms (Fig. 1) transmits to the concrete foundation the weight of the rotating parts of the generator and turbine as well as the water load of the turbine runner, in all 960 tons.

The set has three shafts—turbine shaft, generator shaft and exciter shaft. The first two shafts are connected to one another by means of a flange coupling which transmits the torque, which, at the rated load, is not less than 1,170,000 kgm (8,460,000 foot pounds). The generator shaft is 5.16 m (15.93 ft.) long and has minimum diameter of 1,150 mm (45.3 in.). The exciter shaft is considerably smaller and extends from the upper edge of the rotor hub, where it is bolted to the end of the generator shaft, up through the upper guide bearing and exciter to the tachometer generator at the top of the set.

While work was progressing with the joining of the stator winding, and as soon as the turbine shaft had been properly aligned, the generator shaft was raised into a vertical position, the supporting parts of the thrust bearing mounted and the shaft lowered until it rested on the bearing. After this, the assembly of the thrust bearing and lower guide bearing could be completed (Fig. 2).

While the winding work was being carried out, the rotor, which had been set up at one end of the machine hall, was also being assembled. The stacking

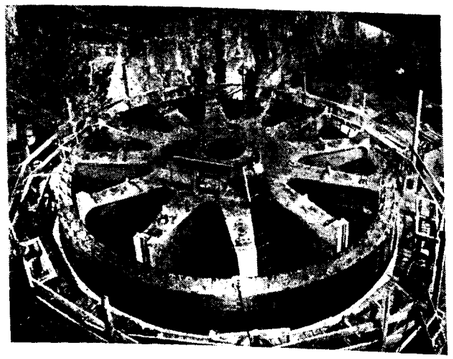


Fig. 3. In order to facilitate transport, the rotor spiders have been divided up into four sections. A complete rotor rim weighs 240 tons and comprises about 15,000 sheet-steel segments with a thickness of 2 mm (0.08 in.). As the height of the rim increases during the stacking of the segments, these are pressed together at certain intervals, as shown in the picture. (52189. Photographed by Ekholtz)

of the rotor segments (Fig. 3), which was carried out at the above-mentioned site, was completed before the stator parts arrived at the power-station. Since this work has already been described in connection with the Harspranget generators, see, for example, the Asea Journal 24(1951) :4, pp. 59—62, it will not be dealt with here.

The rest of the erection work for the generators was carried out mainly in the same way as for the Harspranget sets, see the article in the Asea Journal 26 (1953) : 3–4, pp. 43—51. Quite different methods were adopted, however, for assembling the generator shaft and rotor. The two procedures will therefore be described here in greater detail.

At Harspranget, the work was carried out at the rotor erection site at the end of the machine hall. The rotor was placed on trestles about 1 m (3.3 ft) above the floor level. The shaft was set up in a pit beneath the rotor hub After a hook of the overhead crane had been coupled to the top of the shaft, this was lifted up into the rotor hub until it reached the correct height in relation to the hub. The rotor was then secured to the shaft with shrink-rings fitted around the upper and lower part of the rotor hub.

Since the diameter of the shaft is only about 0.1 mm (0.004 in.) less than the inner diameter of

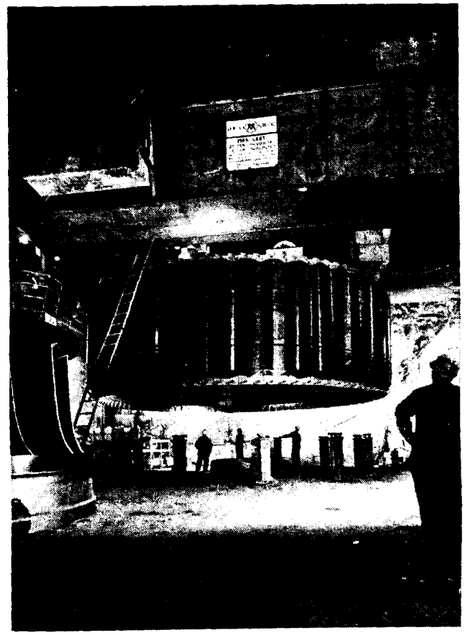


Fig. 4. The complete rotor is raised from its site of erection in order to be moved to the generator pit and lowered into the stator. To the left of the illustration, part of one of the turbine runners can be seen. (52192. Photographed by Ekholtz)

the rotor hub, there is a slight risk of the surfaces of the shaft and rotor hub seizing should the shaft be inclined in relation to the hub when the shaft is being inserted. This risk is small, however, since the shaft is freely suspended from the hook of the overhead crane and therefore automatically assumes a vertical position when it is lifted into the hub. The hub can be carefully checked by means of precision spirit levels to ensure that it is vertical.

After the above procedure had been carried out, the rotor with the shaft was moved by means of a yoke coupled to two overhead cranes along the machine hall to the generator pit where it was lowered into its position in the stator. After this, the assembly of the thrust and guide bearing beneath the rotor was completed.

As has already been mentioned, at Stornorrfors, the erection of the guide and thrust bearing was completed in the generator pit (Fig. 1) while the rotor was being prepared in its erection site at the end of the machine hall. When this part of the erection

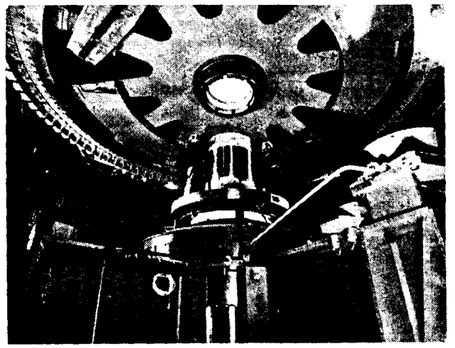


Fig. 5. The rotor seen from inside the stator while being lowered. The shaft, which has a diameter of 1,150 mm (45.3 in), is being given a coating of grease to prevent it from seizing when the hub is placed on it. After the rotor has reached its end position, the 4-ton shrink-ring (on which the erectors are standing) is heated with gas flames from the piping beneath the ring. When the shrink-ring has expanded sufficiently, it is placed around the lower part of the rotor hub visible in the photograph where it is allowed to cool down and secure the rotor to the shaft. A corresponding shrink ring is also mounted on the top of the rotor. (52195. Photographed by Ekholtz)

work was ready, the rotor was moved by means of two overhead cranes coupled together (Fig. 4) to a point immediately above the generator shaft. The rotor was then lowered until the top of the shaft entered the rotor hub and the rotor assumed the correct vertical position in relation to the shaft (Figs. 5 and 6). The rotor was then secured to the shaft by means of shrink-rings in the same manner as a Harspranget.

When the rotor was being lowered, a check was made to see that it was horizontal and the hub vertical with the aid of two spirit levels placed at right angles to each other, giving a deflection of one scale division if the rotor inclined by more than 0.02 mm/m.

This erection method, which has previously been used for about twenty other generators, reduced the lifting capacity of the overhead cranes by about 60 tons. The reason for this was that it was not necessary to load the overhead cranes at Stornorrfors with the weight of the generator shaft and thrust-bearing collar (57 tons) while the rotor was being lowered, which would have been the case if the Harspranget method had been adopted. The heaviest lift (465 tons) was thus carried out at Harspranget despite the fact that the generators there have a lower output (105 MVA at 167 r. p. m.) than at Stornorrfors (150 MVA at 125 r. p. m.) The heaviest lift at the latter site was 445 tons.

In conclusion, it may be said that the method adopted for lowering the rotor on to the shaft employed at Stornorrfors gives the following advantages :

1. The cost of the overhead cranes is lower.
2. The height of lift required in the power-station is often reduced. In most cases the height of lift required for lowering the rotor is the decisive factor when determining the height of the machine hall. This will consequently lower the civil-engineering costs.
3. The erection time is shortened, since the shaft as well as the thrust and guide bearing can be mounted complete, at the same time as the assembly of the rotor is being carried out and the stator is being wound.

After the rotor had been lowered into position, the final erection work on the generator was performed in the same way as described for the Harspranget sets. The generators in this case too were not completely erected in the workshop prior to their dispatch to the erection site. The final delivery tests were made in the power-station.

COMMISSIONING

It has alredy been mentioned that the tests carried out in conjunction with commissioning were performed extremely rapidly. As can be seen, the initial running period of three days for generator No. 2 was particularly short.

The results of the initial running tests of the sets were very satisfactory. As a matter of curiosity it might be mentioned that no balancing at all of the 450-ton rotor of generator No. 1 was required. After 5 months' continuous service, the running of the set is as smooth as when it was commissioned. The shaft readings with a dial indicator at normal speed were (0.002 in) double amplitude measured on the exciter shaft on a level with the upper guide bearing, and 0.03 mm (0.001 in). double amplitude measured on the main shaft adjacent to the coupling flange for the turbine shaft.

The same tests were also performed on the other two sets. During the three days in which the initial running tests were performed on generator No. 2, the following main tests were made :

1. Running tests on the bearings.
2. Overspeed test with max. 150 per cent of the rated speed and braking test.
3. Running of the set with the terminals short-circuited in order to dry the stator winding followed by a successive increase in the stator current until a winding temperature of 60–65° C was obtained. This temperature was maintained until the insulation resistance of the winding became sufficiently high.

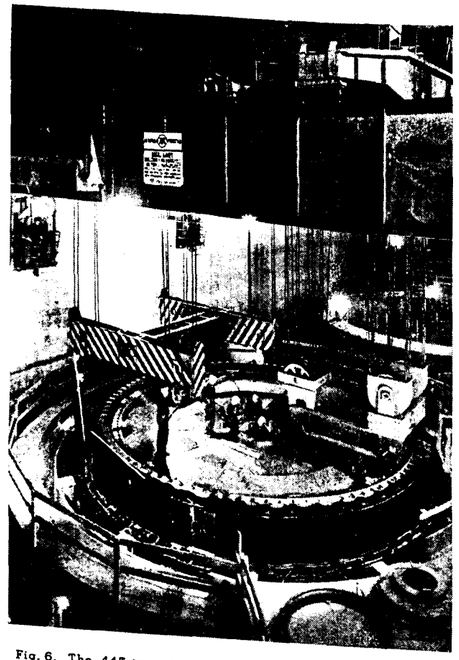


Fig. 6. The 445-ton rotor being lowered into the stator with the aid of two coupled overhead cranes and a yoke. The alignment of the rotor hub after reaching the upper edge of the generator shaft must be extremely accurate both in relation of the shaft and vertically. When the rotor is 300 mm (11.8 in.) from its final position on the shaft, the diameter of the rotor hub is only 0.1 mm (0.004 in.) greater than that of the shaft. (52197. Photographed by Ekholtz)

4. Running of the generator at full voltage on open circuit and measuring of any magnetic unbalance or magnetic displacement of the rotor.
5. Over-voltage test with full excitation at 150 per cent voltage.
6. Adjustment of the electro-hydraulic turbine governor (type Asea-Nohab) and the generator voltage regulator (of transductor type.)
7. Testing of the relay protections by simulating fauits.
8. Synchronising with the grid, putting under load and disconnection tests at successively increasing load.

Finally, it should be mentioned that since the rotor rim was assembled at the power-station, it was naturally impossible to carry out any operating tests in the workshop before commissioning the sets. It is therefore gratifying to note that the tests performed in the powerstation verified the calculated guarantee values in the best possible manner.

(Courtesy : Asea Journal – Vasteras – Sweden.)

Automatic Milling Machines Made in Hungary

By Chief of Publicity Dept.
"TECHNOIMPEX—BUDAPEST"

USERS have brought forward higher demands against knee-type milling machines. To comply with every requirement, Csepel Machine Tool Factory have developed knee-type milling machines of 520 mm. table width. The members of the new machine family are : Universal Milling Machine Type MUP 320. Vertical Milling Machine Type MFP 320, Copying Milling Machines Types MUM 320 and MFM 320. Soon they will be joined by Punch Card and Punch Tape Milling Machines Types MUL and MFL with digital selectors, at present under development.

Modernization is only possible through significant improvement in the automation of the machines. Constructions at which reversals and gear switches are operated mechanically are very difficult to automatize.

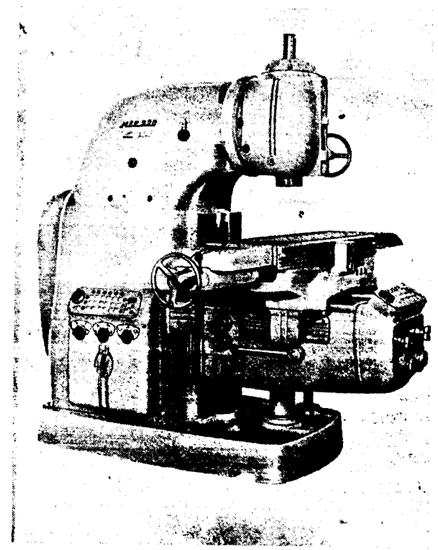
The automatic operation of shift gears and claw clutches demands expensive, intricated devices. This is why all gear shifts involving automatic operation in the 320 type machines are remotely controlled, through electric relays. With the exception of the direct starting of motors, the operating organs of the machines are electromagnetic disc clutches, designed especially for the coupling of table motions and directions.

Standard milling machines—due to inertia—allow the table a very slight motion, after the motor has stopped. The extent of the motion varies in direct proportion to the speed of the feed, and in indirect proportion to the resistance to overcome. In order to ensure instantaneous, accurate stop, machines type 320 have been equipped with a slow feed device of 10 mm/min., independent from working feed. The slow motion device renders stops of an accuracy to 0.02 mm. possible.

Perfectioned automation, as well as accurate stopping and reversing devices entail highly important advantages.

One of the most significant achievements is the considerable reduction of down times. For instance, if there is a job to be machined to accurate dimensions on four sides, normally the operator must keep making measurements or observing the micrometer device, lest the work piece should become a waste. The same work can be done on a 320 type machine under ideal conditions, within a cycle programmed in advance. Stretches where no machining is needed are passed by in quick motion : there comes a rapid and accurate change of direction at the proper point, and having finished the cycle, the table returns to starting position.

Built-in automatic control devices take care of all operations occurring in normal work. They free the operator from physical and mental efforts and open the way for the simultaneous handling of several machines with a single operator.



MFP Vertical Milling Machine

The main technical data of the milling machines type 320 are the following :

Table dimensions	320×1250 mm.
longitudinal motion	900 mm.
traverse motion	300 mm.
vertical motion	400 mm.
Number of spindle speeds	20
Spindle speed range	19 to 1500 r.p.m.
Number of feeds	24
Feed range	12800 mm/min.
Quick motion	2 m/min.

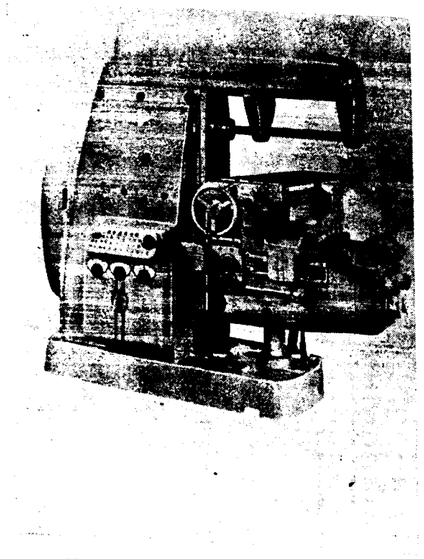
Feed and quick motion of knee are half of longitudinal and traverse feeds and quick motions, respectively.

Main motor power	7 kW.
Secondary motor power	1.7 kW.
Weight of machine	3400 kg.

The above technical data furnish information on the possibilities regarding technology and the size of the works to be handled. They do not disclose anything as to the degree of automation, though in the designing of the machines most thoughtful consideration has been given to all points connected with the possibility of automatic operation.

The machines allow the setting of 103 diverse cycles, to be devised of combinations of feed, quick motion, slow motion, pendulum cycle and clearing cycle.

Universal milling machine MUP 320 is of identical construction with the vertical type, the difference between the two equipments lying in the design of their shape, required by the position of the milling spindle. A further difference between the two machines is that whereas the cross-slide of the vertical miller is rigid, that of the universal machine is composed of two parts and can be turned in a horizontal plane.



Universal Milling Machine Type MUP 320

The copying milling machine, developed from programme-controlled miller type 320 lends itself to the machining of dies, cam disks, reliefs and other works after templates.

Copying milling machine has an electro-mechanic operating system. The sensing element has three pairs of feelers, thus being able not only to switch on motions along co-ordinate axes, but also to bring about compound motions. The feelers pass very slight current. This lengthens their service life and permits to leave a slight clearance between the contacts, thus improving the sensitivity of the device. Signals coming from the feelers pass through a transistorized amplifier to the one-disk electromagnetic copying clutches controlling the table motions.

Copying milling machines can be set to manual and to automatic control. The latter is advantageous when a work has to be copied all around, or in milling dies in series.

The exportation of Milling Machines type 320 is given in the care of " TECHNOIMPEX " Hungarian Machine Industries Foreign Trade Company, Budapest, 62. Postafiok 183.

Excavators of Czechoslovak Manufacture

By Ing. Milon Rataj
Research Institute of the Building Industry, Praha

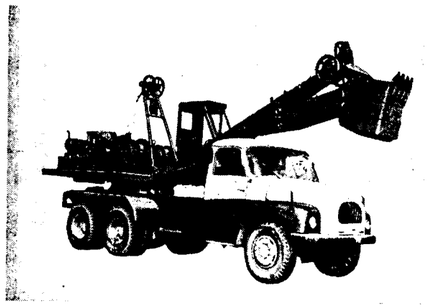
SHOVEL excavators on a tracked undercarriage have been manufactured in Czechoslovakia for many. Their production was started more than 40 years ago by the SKODA Works in Plzen, which has manufacturing experience of many years standing and belongs among the most experienced engineering works in the world in every manufacturing line. Czechoslovak excavators have been exported in large numbers to many countries all over the world, particularly to the Federal Republic of Germany, France, Austria, Sudan, Indonesia, the SSSR, China, Poland, the German Democratic Republic, Bulgaria and many others, totalling in all 35 countries. This is undoubtedly a sufficient proof of the high quality of all excavators of Czechoslovak make. Czechoslovakia manufactures now several types of excavators the main parameters of which are given in the enclosed table. The article will endeavour to give a concise survey of the most important types of excavators manufactured by the Czechoslovak engineering industry.

LORRY-MOUNTED EXCAVATORS

Lorry-mounted excavators are manufactured in Czechoslovakia by the National Corporation of Podpolianske strojirny /Podpoliana Engineering Works,/ Detva. The excavator proper is mounted on a Tatra 111 lorry undercarriage, the entire machine being known under the type denomination of D 030 A. However, the manufacture of an excavator of a new design which has better technical and output parameters has been started. It will later be mounted on a Tatra 138 lorry under-carriage. This lorry-mounted excavator will be known under the type denomination of D 031 a.

The main advantage of lorry-mounted excavators is their high travel speed over roads. The world famous and well proved Tatra undercarriage permits a speed of up to 60 km per hr. over roads and is a guarantee of a reliable and speedy travel also on difficult open ground. Its maximum travel clearance is 3.8 to 3.9 m and it enables a safe passage over almost any type of road.

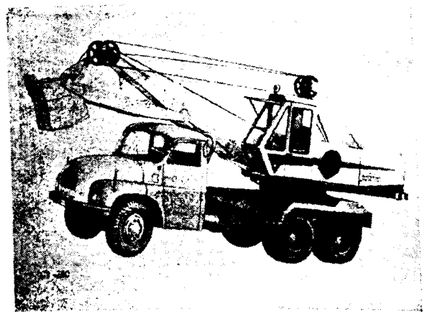
The Czechoslovak lorry-mounted excavator is of sturdy design and can thus be used for heavy-duty operation where other lorry-mounted excavators cannot be used due to the fragility of their design and undercarriage. The universal equipment and the possibility to change the trench digging hoe into a forward digging shovel, or vice versa, without the necessity of any other equipment have enabled the widest possible utilization of these excavators on building sites of every type.



Lorry-mounted excavator, type D 031 a, with engine room covers dismounted

In addition to the norml forward digging shovel with a capacity of 0.35 cu. m for heavy earth, the excavator can be equipped also with a shovel with a capacity of 0.5 cu. m and 1 cu. m for loading light earth and for application in agriculture. When using the latter quoted shovels the excavator has a much higher output.

The technical improvement of the new type of lorry-mounted excavator consists in the more efficient excavation engine, as the original SKODA 3 S 110 engine with an output of 36 to 45 HP has been replaced by an air-cooled engine of Tatra T 924 A type with an output of 60 HP. The increased output of the engine has enhanced also the working speed of the shovel motion and its digging force,



Lorry-mounted excavator, type D 031 a

while the more useful utilization of the design has permitted reduction of the weight of the excavator by 1 ton and elimination of the counterweight. Another advantage is the pneumatic control, which is very convenient. The cabin affords a very good survey of the working site and does not exceed the common travelling clearance. The design of the new lorry undercarriage has eliminated the hydraulic supports since the rear part of the machine with the excavator equipment rests during operation directly upon the axles by means of a special equipment. Elimination of the hydraulic supports has enhanced the operating ability of the excavator and simplified its design.

Lately there has been started the manufacture of a special undercarriage without the lorry engine, in the case of which the travel of the machine is derived from the excavation engine, allowing a maximum speed of 20 km per hr. The excavation equipment applied is the same as with the above mentioned type. This machine is known under the type denomination of D 031 k.

EXCAVATOR WITH A SHOVEL CAPACITY OF 0.5 CU. M

The original type D 500 excavator was designed in the Skoda Works, Plzen, the manufacture being transferred later to the National Corporation of Unicovske strojirny /Unicov Engineering Works/ in Unicov. In 1958-59 a new excavator, the type D 051, was designed. This excavator has very good technical parameters and is one of the best in the world. It is intended for digging and loading of sand, gravel, stone rubble, coal and disintegrated schist. More compact earth must be first disintegrated by means of explosives.

The weight of the excavator is only 17 tons and it is not necessary to use the counterweight with the forward digging shovel. It is installed only for use with further operating equipment and weighs 1 ton. The Skoda 6 S 110 engine has an output of 72 HP at 1200 r. p. m. and enables a large digging force of 10.8 tons at a considerable operating speed. The operating cycle is very short, thus increasing the theoretical output of the excavator, which amounts to 112 cu. m per hr. The wide tracks cause a low specific pressure of 0.58 kg per sq. cm and thus travel over soils with a low load bearing capacity. The excavator is controlled pneumatically and physical fatigue of the operator has been reduced to a bare minimum. He can, therefore, be more alert and

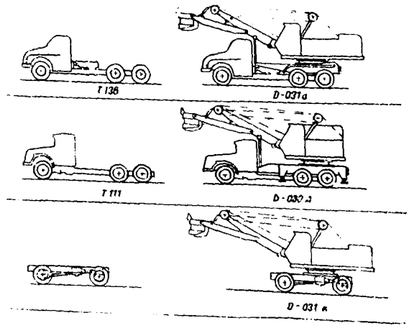


Diagram of lorry-mounted and wheel undercarriage excavators and their type denominations

Tatra 138 lorry undercarriage	Lorry-mounted excavator, type D 031 a
Tatra 111 lorry undercarriage	Lorry-mounted excavator, type D 030 A
Wheel undercarriage	Self-propelled excavator, type D 031 k

improve the output of the excavator. The comfort of the operator has also been increased by heating the cabin in winter and by protecting it against the heat of the engine in summer. The combined thrust of the shovel is a great advantage of the type D 051 excavator, since the machine can work, if required, with a thrust depending upon the stroke of the shovel, and after a small adaptation with an independent thrust. The dependent thrust is more suitable for heavy earth, while the independent one

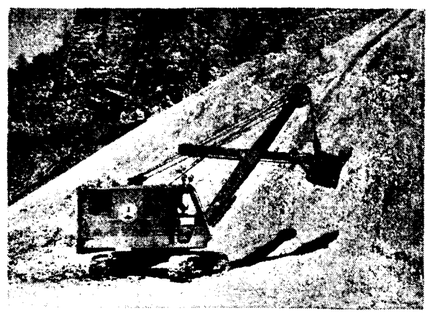
can be used to advantage in light earth. Another advantage of this excavator is a jib common for the forward digging shovel and trench digging hoe. The above mentioned improvements mark the extraordinary standard of design of the type D 051 excavator.

The trench digging hoe has a capacity of 0.5 cu. m. i. e. the same as the forward digging shovel, which for light earth can also have a capacity of 0.75 cu. m. Universal operating equipment is supplied which is applicable for all types of excavation work. The drive of the driving travelling wheels is contrary to the older type, carried out by means of a chain transmission. The diesel engine can, if required, be replaced by an electric motor with an output of 50 kW.

EXCAVATORS WITH A SHOVEL CAPACITY OF 1 CU. M

The Czechoslovak excavator with a shovel capacity of 1 cu. m. is manufactured by the National Corporation of CKD Slany, is one of the oldest in the world and has an excellent technical standard. During the last 40 years it has been subjected to many improvements which have resulted in long, defectless operation of this excavator.

The type Ry 1 excavator can safely dig and load very heavy earth ; only rock, prior to loading, must be disintegrated by means of explosives. The Skoda 4 SB 160 and 6 SB 160 engine have outputs of 90 and 125 HP respectively at 750 r. p. m. and are started by means of compressed air. Gears are used for transmission purposes entirely and they permit any arbitrary combination and simultaneous operation of



Universal shovel excavator, type D 051, mounted on tracked undercarriage and driven by a diesel engine

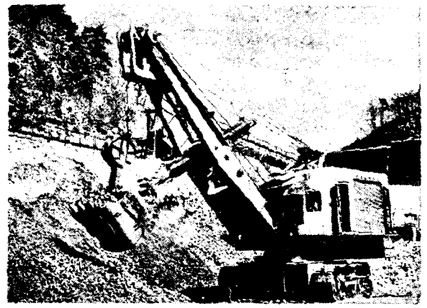
working members, the output of the machine thus being increased. The excavator is controlled mechanically, however, with great ease. The servicing and maintenance of the excavator are also unpretentious. The rear of the engine house has been reserved for the counterweight, that amounts to 5.2 tons. Due to its sturdy design transport of the excavator is simple both on a trailer and by rail, as stripping for the purpose of maintaining the railway clearance is easy and quick.

The newest Ry 150 type has a considerably higher output at a lower weight, since a 125 HP engine has enabled a higher operating speed and a higher digging force amounting up to 20 tons. The driver's comfort has been enhanced by heating the cap and by insulating it against heat from the engine.

The high-grade engine, simple control and defectless operation of this excavator, even under heavy duty conditions, are the best prerequisites of reliable and economic application of this excavator on building sites of every type.

EXCAVATOR WITH A SHOVEL CAPACITY OF 2.5 cu.m.

The type E 25 excavator with a shovel capacity of 2.5 cu.m. is manufactured by the Unicov Engineering Works, National Corporation. The excavator is intended for the heaviest and biggest excavation works in mines, cement mills and wherever long-term use is indicated. The constructional weight of the type E25 excavator amounts to 94 tons, including the transformer, the counterweight weighing another 20 tons. The tract undercarriage is manufactured in three different specific pressures of from 1.0 to 1.8 kg. per sq. cm. The excavator is driven electrically by three electric motors. The biggest motor has an output of 130 kW and is used for the hoist of the shovel and of the jib, as well as for travelling. The second motor, of an output of 60 kW, is used for slewing, while the third motor of an output of 57 kW is used for the sliding movement of the shovel. Another electric motor with an output of 1.1 kW is used for driving the lubrication oil pump and yet another with an output of 7.5 kW for driving the compressor. The electric current voltage can be 380, or 500 V, as required. The excavator can also be fitted with a transformer and can then be fed with high tension current. The excavator has a great advantage in that the motor for sliding the shovel is mounted directly on the jib and thus the winding drum with the rope for sliding the shovel have been eliminated. In order to



Giant shovel excavator, type E 25, electrically driven

prevent inadvertent sliding of the shovel the jib is fitted with an electro-hydraulic braking device which keeps the shovel in the required position with the motor switched off.

Static condensers have lately been fitted to the excavator which have economized the supply of electric current to a considerable extent, since they improve the power factor.

A small light transformer 500 VA is used for distribution of safe low voltage in the excavator for lighting and for electric hand appliances. The quiet run of the entire machine and of the electric motors facilitates servicing, which is comfortable and easy. The cabin can be heated, as required, and maintenance is very simple.

For tropical conditions the excavator is fitted with all necessary protections which have been successfully tested under the most difficult conditions. The excavator is supplied dismounted and its assembly is carried out by experts of the manufacturing works. Simultaneously they train the excavator crew and carry out the first testing of the machine. The simplicity of the entire design results, of course, in a long operating life of the excavator which, together with its unpretentious servicing and control, ensures its economic operation for many years.

Manufacturing experience of many years standing, careful testing of the excavators and systematic study of the operation of the excavators have enabled the manufacturing works to improve systematically their designs and outputs, so that now the above mentioned excavator types belong among the best in the world. In conclusion it must be mentioned that the development of small hydraulic excavators with a shovel capacity of 0.15 cu.m. mounted on the undercarriage of the world known Zetor tractor, as well as of an excavator with a shovel capacity of 0.4 cu.m. is now being carried out in Czechoslovakia. These excavators will supplement the series of Czechoslovak excavators, which are able to cover every demand for digging and loading of materials of every type under various climatic and earth conditions. Precision of manufacture and high-grade material together with the long tradition of Czechoslovak industry form the basis for further successful production and export of excavators to many countries.

The sole exporter of all Czechoslovak excavators is the Foreign Trade Corporation of Strojexport, Praha.

Main technical data of the Czechoslovak excavators

Excavator type		D 030 A	D 031 a	D 500	D 051	Ry 1	Ry 150	E 25
Type of undercarriage		Lorry undercarriage	Lorry undercarriage	Tracked undercarriage		Tracked undercarriage		
Capacity of normal forward digging showel	cu. m.	0.35	0.35	0.50	0.50	1.00	1.00	2.50
Capacity of shovel for loose earth ..	cu. m.	0.50	0.50–1.00	—	0.75	—	1.50	—
Output of the excavator engine ..	HP	45	60	48	72	90	125	3 el. motors input of 247 kW
Output of lorry engine	HP	180	180	20.2	17.0	34.8	33.5	94
Constructional weight..	tons	17.2	16.7	22.3	18.0	40.0	39.5	114
Operating weight ..	tons	18.5	17.0	7.0	10.8	13.4–18.3	17.7–20.0	36
Maximum digging force	tons	4.0	4.2	4.5	5.1	4.05	4.24	3.5
Slewing speed of excavator superstructure	r.p.m.	5	5.7					
Time of 1 operating cycle at a 90° slewing	sec.	16	14	27	16	22	16	40
Theoretical output per hr. ..	cu. m. per hr.	78	90	67	112	164	212	225
Type of control ..		mechanical	pneumatic	mech.	pneum.	mech.	mech.	pneum.
Specific pressure ..	kg. per sq. cm.	—	—	1.06	0.58	0.98	0.98	1.00–1.80

Two U.K. Atomic Power Stations to be Ready Soon

IMPORTANT STAGE REACHED IN CONSTRUCTION

An important stage has been reached in the construction of the first two of the seven atomic power stations now being built in Britain. These two—at Bradwell, Essex, and Berkeley, Gloucestershire—will soon be adding 150,000 kW and 137,500 kW and respectively to the 300,000 kW already being fed to the national Grid by the reactors at Calder Hall, Cumberland, and Chapelcross, Dumfriesshire.

At both Bradwell and Berkeley the first half of each station—the reactor with its boilers and turbo-generators—has been completed and fuel loading will be started soon. The second half will be be completed in the next few months and the stations will be delivering a minimum of 300,000 kW and 275,000 kW to the Grid by the autumn of 1962.

Following the loading of fuel, permission to start up the reactors will be given in about November. The reactors will then be gradually worked up until they begin to supply power to the Grid in December and become fully operative early in the new year, ready for the official opening of both stations in the spring.

The capacities of the seven stations now being built, with the outputs of Calder Hall and Chapelcross, will bring the total of Britain's atomic capacity to more than 3,300,000 kW.

Current Trends in Polymers and Copolymers of Styrene

(Special to Journal of Industrial Engineering, Bombay)

By Gordon B. Thayer

[Mr. Thayer is project manager of Plastics Technical Service in Italy and Greece of Dow Chemical International S.A. A recognized authority on plastics molding techniques, Thayer has been a regular contributor to technical publications of this industry, and is the author of PLASTICS MOLDS. He is a member of the American Society of Mechanical Engineers.—EDITOR]

IN spite of the fact that polystyrene is one of the oldest thermoplastic raw materials, styrene plastics are very much alive and growing today. Not only are newer copolymers of styrene being developed, but even polystyrene itself, the "work-horse" of the industry, is being engineered into new formulations. These technical advances have made polystyrene suitable for entire new industrial applications which have opened up important developments in construction, lighting, packaging, and many other industries.

This expansion of polystyrene plastics came about both as cause and effect of an expanding range of potential applications. An important factor in developing refined polymers and copolymers of styrene was the refrigeration industry, the largest user of high impact polystyrenes. The building industry provided a market which justified the expensive research and development costs of foamed polystyrene. The packaging industry needed a low cost, high clarity transparent film. The automobile and appliance industries provided many areas of application for copolymer resins that compromised the polar considerations of economy and performance.

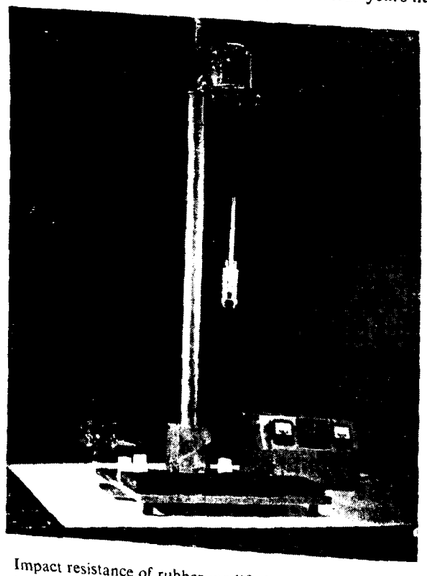
Much of the success of polystyrene plastics is due to the partnership role the raw material suppliers have had with manufacturing companies in diverse industries. The resulting technical advances have made an impact in the plastics industry world over.

Polystyrene is destined to play its part in India's aggressive industrialization program. Local production, through such firms as Polychem Ltd., will market this versatile material, making it available to Indian plastics fabricators, and through them, to India's consumers. Items that may have once been considered small luxuries to many, such as combs, toothbrushes, soap dishes, and toys, can now be made available in good quality at low cost.

Polychem is a new company is which The Dow Chemical Company owns a minority interest. Now Dow is contributing its technical know-how to Polychem's production of some 20 formulations of Styron, Dow's Polystyrene. Since many Indian Industrialists will have increasing occasion to use this plastic in one, or another, of its forms, a brief review of its applications and progress is in order.

GENERAL PURPOSE POLYSTYRENE

The wide range of formulations and variations of polystyrene developed during the past several years has



Impact resistance of rubber modified polystyrene formulation is measured by falling dart dest. Up-to-date customer service laboratories, such as those maintained by Polychem Limited, are important for continued growth of polystyrene.

The outdoor weatherability of Styrene/methyl methacrylate compolymers makes them ideally suited for such applications as this decorative grillework used to modernize an old building.

enabled an increasing range of applications in appliances, housewares, and packaging.

Improved moldability of general purpose polystyrene is one of the main factors in enabling the production of many packaged items in large quantities at low manufacture cost. At the same time, increased toughness and heat resistance have been combined with molding improvements to allow the plastic to be used in a wider range of houseware applications because it will withstand more severe use conditions.

LIGHT STABILIZED POLYSTYRENE

The addition of light stabilizing ingredients has made it possible to neutralize polystrene for diffusers in fluorescent lighting fixtures.

Light stabilized styrene polymers resist ultra violet degradation in light diffusing applications like this attractive translucent drapery.

Polystyrene, stabilized to resist the yellowing influence of fluorescent lamps, transmits light nearly as well as more expensive polymers and stays white long enough to provide economical diffusion. Molding and extrusion grade resins of light stabilized polystyrene offer superior colour stability under fluorescent light radiation.

Performance of these resins under accelerated aging tests reveal yellowing of only one seventh of the allowable maximum specified by the Council of Illuminating Engineering Society. Test methods followed recommendations by a joint committee of IES, the Society of Plastics Industry and the National Electrical Manufacturers Association.

These developments have been significant in extending considerably the use of polystyrene in the fluorescent lighting fixture industry.

RUBBER-MODIFIED POLYSTYRENE

Rubber-modified polystyrenes have expanded into numerous formulations and are expected to gain a large share of the rigid package market.

Injection molding can produce excellent packages, with molded-in letters and trademarks. Below molding can produce complex shapes without internal mold cores. Extruded sheet, vacuum formed, accounts for further extending the range of package applications.

During the past 15 years these plastics have been used in constantly increasing amounts in the household appliance industry. Currently the refrigerator industry uses rubber-modified polystyrene almost exclusively for refrigerator inner doors. Many refrigerators have the food container portion made of this material and there are likely to be increases in the use of plastic for this purpose during the next two years.

STYRENE COPOLYMERS

There are now several important styrene copolymers. Most of these have been developed for special properties but at the same time they also provide an excellent balance of other physical properties and ease of fabrication.

Styrene/acrylonitrile copolymers range from 10 to 35 per cent acrylonitrile, with chemical resistance and strength improving with increased elongation. It is possible to select materials from three different percentage ranges of acrylonitrile and to balance physical properties or chemical resistance requirements against cost.

The high tensile strength is the principal factor for the use of styrene/acrylonitrile copolymers in television safety lenses and electric storage battery containers. Chemical resistance is the reason for the wide range of applications from drinking tumblers, which do not stress crack from the butter-fat in milk, to filter bowls for diesel fuels. Large volume applications include washing machine filter bowls, thermal wall tumblers small household appliances, refrigerator crisper shelves, packaging components and office machine parts.

Styrene/methyl methacrylate copolymer is a water-white transparent resin of different chemical resistance from that of polystyrene. The commercial copolymer of styrene/methyl methacrylate has good properties for a wide range of applications in the automotive, appliance and sign industries.

Control knobs and electric fan blades with metal hubs can be made of this polymer because it has sufficient elongation. It can be extruded as transparent sheet, and it can be vacuum formed. Its outdoor aging shows good retention of physical properties and makes it suitable for outdoor advertising signs.

Polystyrene films can be treated with special coatings to give them added qualities such as anti-fogging characteristics, as shown above.

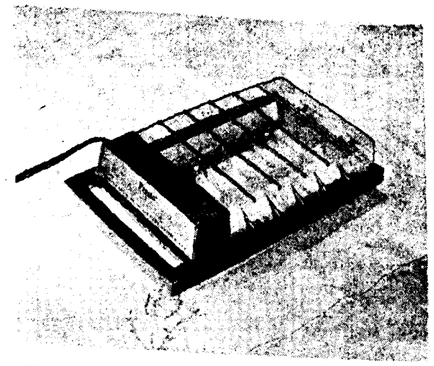
EXPANDED POLYSTYRENE

Currently there is a great deal of activity to determine fabrication methods for producing and working various kinds of foams. There are several forms of polystyrene foams available and their applications are growing in many directions.

Molded foams are highly adaptable for thermal insulation, containers, decorations and package lagging or filler pieces. Recently, the use of polystyrene foams as core-stock in sandwich construction has become important because of refinements in making wide foam boards of uniform thickness and dimensional stability.

POLYSTYRENE FILMS

Biaxially oriented films of polystyrene were originally made for electrical insulation. Improvements in manufacturing methods and equipment brought about heavier films for a wider variety of uses, ranging from green-house glazing to light diffusing ceiling panels to overwraps for certain fruits and vegetables which need to "breathe" air and moisture.



Styrene/acrylonitrile copolymers are used in small appliance applications because of their good chemical resistance and strength properties.

Heavier films are now pressure formed in closed molds to make transparent, printable lids for containers. These films are also effectively used for blister packages.

FUTURE OUTLOOK

The overall future for polystyrene plastics looks good. With expanding world economy, the industrial uses of polystyrene plastics are growing. As the uses of plastics increase so does the range of applications. Because of this growth there are many opportunities to accumulate more knowledge in this field.

The importance of constant research and up to date information on new developments is recognized by such companies as Polychem Ltd., which maintains a technical service organization which studies applications of materials, design of products, and fabrication techniques. It also has liason with The Dow Chemical Company Plastics Department from which it can obtain the latest information on polystyrene plastics. These service facilities enable the company to provide valuable technical help to various branches of Indian industries.

Role of Dia Invest Export in India's Development Plans

THE construction of factories and complete industrial plants plays a decisive role in the development of a national industry. The modern and many-sided industries of the German Democratic Republic readily offer their great experience on this field to all nations that want to industrialize their economies.

The foreign-trade enterprise DIA INVEST EXPORT, representing most of the branches of economy in the export of complete plant, undertakes design, delivery, erection, and commencement of operation of all kind of complete large and small-scale industries. Moreover, DIA INVEST EXPORT lends technical personnel for the direction of the supplied factories, and provides for the training of the customers' personnel.

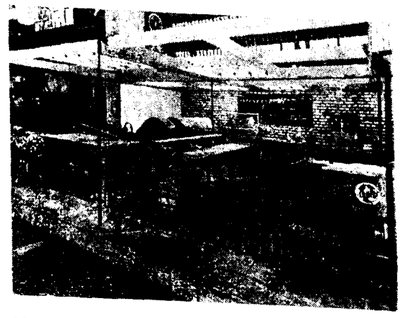
The export programme of this enterprise includes, among others, ore dressing and low shaft furnace plant and equipment for the mining, working and dressing of soft coal and specially for the briquetting of this important material. Manufacturers with experience based on a very long tradition are the suppliers of DIA INVEST EXPORT for cement works and equipment of the building materials industry (glass works, porcelain factories, etc.). DIA INVEST EXPORT also supplies equipment and individual machinery for the sugar industry. Another important export item are power stations and equipment for the transmission of energy. There is an internationally renowned export and erection of complete textile mills, integrated textile industries and the respective partial equipment. DIA INVEST EXPORT can also boast of good success in the export of modern factories for the manufacture of synthetic fibres.

A good cooperation between Indian customers and the DIA INVEST EXPORT has resulted from the export of small-scale industries. The mirror factory, for example, supplied and erected for Messrs. Atul Glass Industries, is now producing to the full satisfaction of the customer.

The existing business relations with Indian partners show that technology and assortment of the equipment supplied by DIA INVEST EXPORT are well appropriate to the special conditions of India.

This is proved by the supplies realized and the contracts concluded with Indian customers for equipment of the chemical fibres industry, plants for the manufacture of welding electrodes and brushes, chemical factories, equipment for the manufacture of sanitary fittings and the appropriate nonferrous metal foundries, plants, for the manufacture of cameras and low shaft furnaces.

The plants designed and constructed by renowned manufacturers of the German Democratic Republic are highly economic and profit earning, e. g. the mirror factory supplied and erected by the German Democratic Republic for India amortizes within one year.



Machinery and Equipment for a Mirror Coating Plant

The assortment for the delivery programme of DIA INVEST EXPORT is selected in the aspect of enabling the customer to save valuable foreign exchange for his country by a local manufacture of goods.

At their request we are ready to undertake the following additional services for our Indian partners :

(1) disposal of the " technical know-how "

(2) training of Indian workers in internationally renowned factories of the German Democratic Republic.

(3) supervision of the erection

(4) supervision of the putting-into-operation and start of production

(5) performance of tests on raw material and finished products in laboratories and combined works in the German Democratic Republic

(6) projecting of buildings.

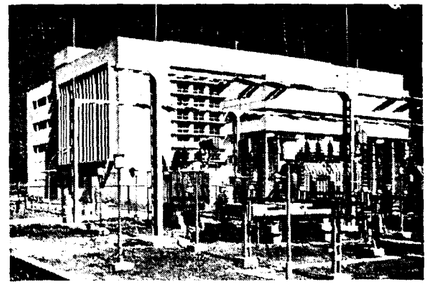
Besides of buying the plant the customers may have the possibility to obtain the manufacturing licence and the trade-mark of renowned factories of the German Democratic Republic.

In all their business transactions the foreign trade enterprise DIA INVEST EXPORT acts according to the principle " Trade to Mutual Advantage ". Messrs. Invest Export are always ready to accept certain Indian supplies and services and to have good

Section of a brush factory equipped with semi-automatic and fully automatic machines

and close cooperation with the Indian suppliers. Especially with the erection of sugar and cement factories a great deal of Indian supplies could be incorporated.

Prerequisite to the supply of complete plants is, of course, the full clarification of the necessary technical conditions (e. g. quantity of raw material available and its composition, water and power supply, traffic and transport conditions, availability of skilled labourer). Now as then DIA INVEST EXPORT will advise their Indian customers in all fields by well trained experts of the German Democratic Republic. This would avoid the customer to get into trouble if not all the problems connected with the erection of a complete plant have been taken into consideration from the very beginning.



View of a Power Station supplied and erected by the German Democratic Republic

On this basis the export of complete plants made to many countries of the world by DIA INVEST EXPORT has greatly developed during the last years. This is demonstrated by the completed supplies of power-generating plants, textile plants and film studios to the U. A. R./Egypt, the export of cement plants to Syria, to Burma and to English customers, the erection of a big sugar plant in Indonesia and the supply of further combinated works, equipment and small-scale plant to Cuba, Ghana, and to all socialist countries of Europe and Asia.

To India our factories are exported within the trade and payment agreement between India and the German Democratic Republic, i. e. the payment can be effected in non-convertible Indian Rupees.

Owing to the afore-mentioned factors the cooperation between the DIA INVEST EXPORT and their Indian business friends is also for the future very promising. Except for supplies of plants manufacturing the traditional " Heavy and Capital Goods " the delivery of design and equipment for theatres, talking-film studios and other industries, too, will promote the development of the business relations between India and the German Democratic Republic.

This will be the contribution of the foreign trade enterprise DIA INVEST EXPORT, Berlin W 8, Taubenstrasse 7-9, to the further industrialization of the Indian economy.

Production of Industrial Cooling Equipment in Czechoslovakia

By An Overseas Correspondent

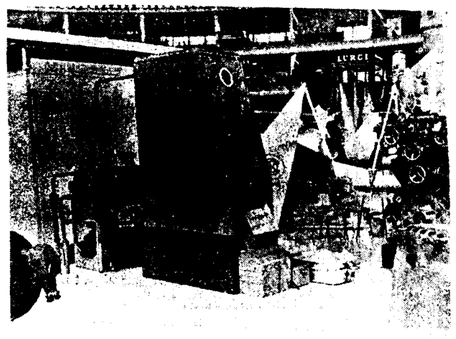
THE production of industrial cooling equipment has a tradition of long standing in Czechoslovakia as the CKD works have designed and manufacture this plant since the year 1887. Especially in the last few years, however, the production has increased to such an extent that Czechoslovakia has become one of the greatest world manufacturers and exporters in this line. The products of the above branch of production are remarkable for their high quality and up-to-date design the proof of which is the fact that our cooling turbo-compressor displayed on the World Exhibition in Brussels was awarded a Great Price.

The prerequisites of this development are double: partly the rapid growth of the cooling and foodstuff industry in Czechoslovakia connected with the rapid increase in the living standard of the population — Czechoslovakia belongs to one of the most advanced countries of the world in the cubage of cooling spaces as well as in the consumption of frozen goods per one inhabitant — partly the large export deliveries of the industrial cooling equipment for foodstuff and particularly chemical industries.

Thanks to the above it was possible to proceed to the extensive typifying of the compressors and other apparatus, e. g. condensers, evaporators, etc. The piston cooling compressors are produced both in vertical design with parallel-flow passage of the coolant in the cylinders and in high-speed, counter-flow design with 2–8 cylinders arranged into V-shape / in case of a four-cylinder compressor/ , into W-shape / in case of a six-cylinder compressor/ and into VV-shape / in case of an eight-cylinder compressor/ , applicable for ammonia and freon. For the outputs exceeding 300,000 kcal/hour a series of compressors usually with cylinders arranged into V-shape — / 4–8 cylinder compressors/ designed for ammonia and freons as well is under completion. The block arrangement with the condenser on a common frame is currently used.

For high coling outputs required especially in the chemical and petrochemical industry a series of cooling turbo-compressors for F-12, propane and ammonia has been developed. In this respect we have acquired an export order for one of the largest cooling equipment in the world—a cascade turbo-compressor equipment operating with propane and ethylene of an output of 3 mil./kcal/h at an evaporating temperature of—110° C.

In the branch of artificial ice the new types of the flake ice making plants of an output of 110 and 220 kg per hour have been placed on the market lately. This plant is in great demand as the application of crushed ice for the fishing vessels and for the preservation of vegetables, fruit, bottled milk, etc. is



Ice producer

constantly increasing. The described ice making plants occupy a very small space and operate without any stuffing box, their design being so solved as to avoid the escapement of the coolant during the operation.

For the making of pressed ice briquettes which are difficult to thaw the new briquetting press BL 400 is supplied.

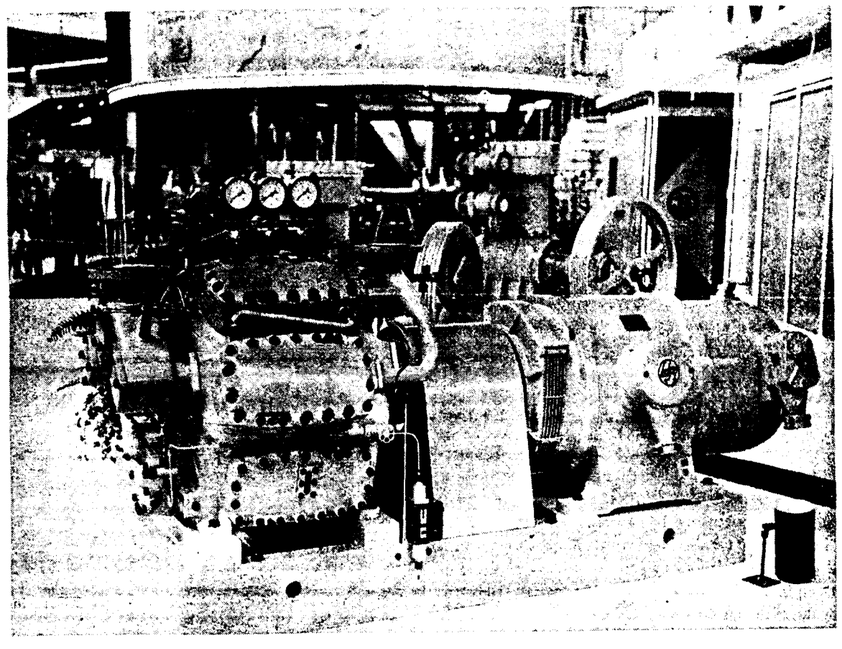
For the freezing of foodstuffs the plate-type contact freezing apparatus are used. These are of approved design with aluminium plates, with a new improved

Czechoslovak complete Industrial Plants for International Exports

By A Special Statistical Correspondent

THE export of Czechoslovak complete industrial plants increases year by year. This is possible due to a steady growth of the standard of the Czechoslovak engineering industry and to the efforts of the Czechoslovak Socialist Republic for a peaceful co-operation and co-existence of all nations irrespective of their social formation.

Czechoslovak was a country with a developed industry before the World War II already. Owing to a great development of production forces in the Czechoslovak territory after the World War II, mainly since the year 1948, the moment of the Czechoslovak industry—especially of the engineering one—has still increased. The Czechoslovak Socialist Republic has ranged with prominent manufacturing countries in the world. After fundamental changes of the structure of the Czechoslovak industry the engineering industry has occupied a priority position, above all the heavy engineering industry. This branch of industry has



Cooling Compressor of NF Series

methed of distribution of the coolant into the plates, with improved hydraulic devices, closure of the casing, etc. Also these apparatus are mostly delivered for export.

All the above equipment including the ammonia compressors of the output above 10.000 kcal/h is exported by Technoexport, Foreign Trade Corporation, Praha.

developed most intensively in the Czechoslovak Socialist Republic. Whereas within the period from 1948 till 1959 the general Czechoslovak production reached 3,3-times the anterior volume, the machine production increased 5,8-times. In the year 1959 the share of the machine production in the general industrial production of the Czechoslovak Socialist Republic reached 32%. The tradition of long standing and the perfection of the Czechoslovak world

Clinker Grate Cooler with Backstroke Crusher 800 x 700 mm and Oil Burner

renowned engineering works, such as V. I. Lenin Works (former Skoda Works) at Plzen, Klement Gottwald Works (Ist Brno Engineering Works) at Brno, Victorious February Works at Hradoc Kralove, Kralovo Pole Engineering Works at Brno, CKD Works in Prague, CKD Works at Blansko etc. have enabled an immense reconstruction of the Czechoslovak industrial production on behalf of the engineering industry.

The world-renowned tradition and high technical standard of Czechoslovak engineering works enable the Czechoslovak Socialist Republic to design, deliver and erect complete industrial plants in a number of branches. The share of the export of complete industrial plants and mechinery in the gross export of the Czechoslovak Socialist Republic exceeded 44% in the year 1959 and will exceed 50% within the year 1965. The increase of the Czechoslovak export of industrial plants and machines is much sharper than in developed capitalist states. Whereas in the years 1948—1959 the share of this export increased almost by 400% in the Czechoslovak Socialist Republic, it increased by 162% only in capitalist states. The export share of the Czechoslovak complete industrial plants into the economically developing countries increases still sharper. In the year 1960 it reached almost 29-times the volume of the export in 1948.

The assortment of the Czechoslovak complete industrial plants which are exported by Technoexport, Foreign Trade Corporation for Export of Complete Industrial Plants in Prague is continuously extended. Actually, Technoexport exports industrial plants for large-scale metallurgical works, plants for steam and water power engineering, plants for chemical and crude oil industry, plants for the production of building materials—cement works and earthenware manufacturing plants, ore dressing and coal preparation plants, plants for the food industry, especially for sugar factories, further engineering works and a number of plants for the light industry, such as rubber processing works and tyre factories, plants for the woodworking industry, river ship building industry etc.

Four-roll Calender 10827 for Rubber Covering of Tyre Cord

By the export of various industrial plants the Czechoslovak Socialist Republic participates with a still increasing activity in the industrial construction works of countries of the Socialist Camp and of economically developing countries. Only within the past years the Czechoslovak Socialist Republic has

delivered through the intermediary of Technoexport several hundreds of complete industrial plants to the whole world which have surpassed the capacities guaranteed by contracts in many cases.

In the branch of the metallurgical industry with the exception of large-scale works in socialist countries—Technoexport constructs large-seale works of the engineering metallurgy at Ranchi (India) within the framework of the economic co-operation between the Czechoslovak Socialist Republic and the Republic of India. According to the concluded contract Technoexport supplies the technical project, documentation and manufacturing plants including also the foundry, forging shop and rough machining shop inclusive of power centres; besides, it grants technical assistance at the construction as well as in the operation of these works by the sending out of necessary experts. To Egypt Technoexport has supplied the machinery equipment for the rolling mill of non-ferrous metals.

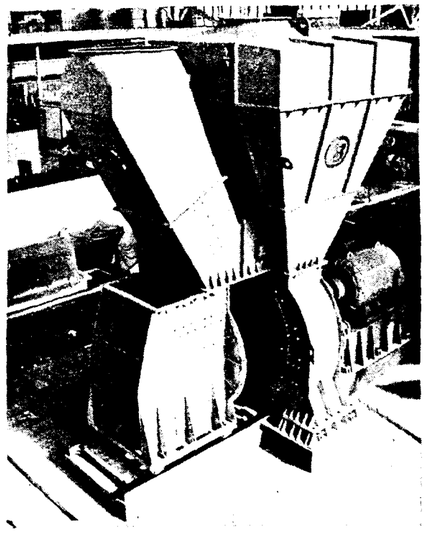
The Czechoslovak industry has got the experience of long standing in the production of plants of the power engineering, which are renowned by their technical standard all over the world. It produces all types of water power plants and has a successful tradition also in the steam power engineering. Technoexport has delivered a number of water power stations to China, Korea, Bulgaria, the German Democratic Recpublic, Poland, Rumania, Brazil, Iceland etc. The machinery equipment for the Bariri water power station in Brazil at Tiete river in the state of Sao Paulo, the capacity of which will amount to approximately 142 kw, represents an important delivery of the water power engineering into capitalist states. The machinery equipment for

United Head Boiler consisting of independent parts adapted to easy transport to the place of destination. The boiler is of radiation type, single-drum, with steam superheater, air heater and with artificial draft and blasting of combustion air.

the steam power station in the Brazilian state of Rio Grande do Sul has been supplied lately.

The deliveries of Technoexport to Rumania, India, Iran and Argentina have linked up to the prewar deliveries of steam power stations to China and Iran. Thus Technoexport has obtained orders in India for the extension of the Utran steam power station at the competition with 20 world suppliers, further for the delivery of the machinery equipment for power stations Jamangar and Shapur. For the largest textile works in Egypt Mobala El Kubra—Technoexport delivered the equipment for the steam power station consisting of two turbo-sets and a boiler. Technoexport has begun with deliveries of the equipment for the steam power station at natural gas in Rumania lately; this equipment consists of 3 power units with 100 MW each. It supplied the equipment for steam power stations Ludus and Graiova to that country already before. Plants of the chemical and crude oil industry of the Czechoslovak production have proved satisfactory all over the world. The greatest delivery of this kind is the plant for the crude oil refinery at Homs, in Syria the production capacity of which amounts to 1 million tons crude oil per year. Further plants of the crude oil industry have been supplied to Egypt. The Czechoslovak Socialist Republic exports chemical apparatuses mainly to the countries of the Socialist Camp, maximum export being effectuated to the USSR. Technoexport will deliver plants for the large-scale chemical works for production of viscose rayon to Poland, for production of cord yarn to the German Democratic Republic etc. After the year 1948 works for production of plants for the building material industry—the Prerov Engineering Works, N. E.—have been constructed in the Czechoslovak Socialist Republic. Actually Technoexport supplies cement works to the USSR, China, India, Afghanistan, Pakistan, Egypt, Celebes, Argentina, Brazil etc. For example in Argentina there are San Louis cement works of capacity of 350 tons per 24 hours, in Brazil of capacity of 200 tons per 24 hours. In the year 1961 further Czechoslovak cement works were supplied to India (Tulukkapatti of capacity of 200 tons per 24 hours), to the West Pakistan the Maple Leaf cement works at Daudkehl of a minimum capacity of 500 tons per 24 hours. The plants of the earthenware manufacturing industry from the Czechoslovak Socialist Republic have proved successful above all in India and Turkey.

In the line of the food industry the Czechoslovak Socialist Republic exports mainly plants for beet and cane sugar factories. Since the year 1945 the export



Fan Mill Type VM 45
In Fan Mills there are prepared less valuable fuels for burning in steam boilers

of plants for sugar factories into the countries of the Socialist Camp has increased—especially to the USSR, the People's Republic of China and to economically developing countries. For example Technoexport has delivered the machinery equipment for 3 sugar factories that show good outputs to India from the year 1957 till 1961. The Panipat sugar factory, assembled and put into operation in a record time of 4 months, processes instead of the guaranteed 1000 tons up to 1250 tons sugar cane per 24 hours.

Further sugar factories have been established by Technoexport in Egypt and Syria and in Ceylon. In Egypt it is the cane sugar factories at Ermant and Edfu that will be furnished with the equipment to the Czechoslovak origin. The sugar factory at Edfu will be one of the largest cane sugar factories all over the world. Its production capacity will amount up to 8000 tons processed cane daily.

In Ceylon the Kantalai cane sugar factory was put into operation within October 1960. In 1961 Technoexport concluded contracts for the delivery of the equipment for the beet sugar factory at Homs, in Syria (there is concerned an extension of the sugar factory supplied by Technoexport 10 years ago, the production capacity of which will amount to 1250 tons processed beet per 24 hours) and for the cane sugar factory in Ghana with a production capacity of 1000 tons per 24 hours, which will be the first sugar factory completely supplied by the Czechoslovak Socialist Republic into the region of central Africa after the World War II. In the framework of the Czechoslovak economic aid to the economically developing countries there has been concluded a contract for the delivery of the equipment for the sugar refinery at Cambodia.

The plants of the engineering industry from the Czechoslovak Socialist Republic have become well experienced in India, in Egypt and elsewhere. In Cuba we construct actually a number of factories for the production of various utility engineering goods. Among them for example a plant producing 40,000 refrigerators yearly.

Technoexport supplies a number of equipment also for the light industry. These are included here plants for the production of utility goods, rubber processing works and tyre factories. The equipment for the plant producing enamelled ware has been supplied by Technoexport to Indonesia. Further, Technoexport has supplied tyre factories to India, Indonesia, in the year 1961 has concluded a contract for the delivery of the equipment for automobile tyre factories to Cambodia and Ghana of a production capacity of 450 tyres per 24 hours each. The production equipment for rubber processing works is supplied by Technoexport to the USSR, Poland, Hungary, Rumania, Bulgaria, Austria, India, Iran, Sudan and Burma.

Besides the mentioned plants Technoexport exports also woodworking machines. Only in the past years these have been put into operation complete plywood factories in Iran, the UAR, Rumania Brazil etc. Even such a rich assortment of the Czechoslovak woodworking machines has been extended by 4 novelties in the year 1961, i. e. by the double-sided thicknesser FR 2 T 80, automatic sharpener NAN 2, sharpener of saw chains BPR and two-roll grinding machine B2V-U.

The stated specification of Czechoslovak complete industrial plants exported by Technoexport in Prague grants only a brief information of their variety and capacities, by which they have well proved in the operation already.

The tradition of the Czechoslovak engineering industry, its continuous improvement under a close co-operation with scientific institutions as well as skilled technical labour grant a guarantee of the first-class quality of Czechoslovak complete industrial plants and make the Czechoslovak Socialist Republic a looked for supplier of industrial plants.

Reversing Four-High Rolling Mill, Dia 170/480 x 400 for Strip Cold-Rolling

A great many objects of common use are manufactured of cold-rolled material. Notably the light industries, the electric industries and in particular the motor cycle industry and the automobile industry produce articles of the material. The cold-rolling process is used for strips of carbon steel and alloyed steel material, of non-ferrous and light metals, as well as of precious metals to be used for instance for the coining operation at mints, a. s. f.

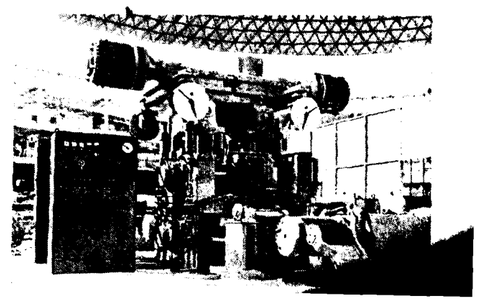
Cold-rolled material displays outstanding properties. With steel material these are ductility for deep-drawing, increased strength, exact thickness tolerances, essential for the pressing of mechanical components, and a good surface quality. Cold-rolled strips of silicon steel material, so-called oriented dynamo laminations and transformer stampings have excellent electrical properties. They therefore find their use in the manufacture of electric motors, dynamos, transformers and electrical instruments of lesser dimensions.

The four-high rolling mill on display at the Brno International Trade Fair 1961 is the model most frequently asked for by our customers, as it permits the rolling of an assortment of such products for which there is the greatest demand on the market, i. e strips of a maximum width of 320 mm to be rolled from an initial thickness of 3 mm to a thickness of 0.15 mm of the finished product, in case of steel material / by equalizing a thickness of 0.08 mm can be achieved /, and with non-ferrous metals a resulting thickness of 0.08 mm. Reversing rolling mills find their use in rolling-mill plants and will do so still for many years to come, notwithstanding the existence of the modern broad-strip mill trains. The reason for this is that on tandem mill trains no such exact thickness tolerances can be achieved. A further reason underlying the continued use of reversing four-high rolling mills is their versatility of application, coupled with the possibility of quick changes in the rolling-mill schedule, the possibility of rolling a great variety of widths, thicknesses and qualities of material.

The rolling mill train on display has been built as official development project of the Czechoslovak Socialist Republic, with a view to test and verify novel elements of electric governing drives, regulating gear and automatic equipment, new structural elements of mechanical components and the selection of the most suitable materials. The rolling speed of up to 10 metres / second / i. e. 600 metres / minute / achieved on these rolling mill trains equalize the world-wide top speed for such equipment, as result of the work of Czechoslovak designers.

The design of the mechanical part of this rolling mill is of painstakingly elaborated theoretical conception, in particular as far as strength is concerned. The operating as well as the supporting rollers have been manufactured of special alloyed steel material, high-frequency hardened to 95° and 65° Shore hardnees, and are carried in special anti-friction bearings of Czechoslovak origin.

As a second alternative feature for the four-high rolling mill a spare set of supporting rollers has been produced for seating in fluid-friction bearings. The fluid-friction bearings have, no doubt, their advantages, however, they require maintenance by experts. The lubrication of the anti-friction bearings as well as of the fluid-friction bearings is of the



Reversing Four High Rolli
for S

circulation type, supplied by the mill's own oil distributing systems.

The two-stage worm transmission gear for the adjustment of the pressure screws of the rolling mill has globoidal toothing. The production of such gearing has been successfully perfected a few years ago by the V. I. Lenin Works / formerly Skoda Works / in Plzen. For the measuring of the pressure of the adjustment screws electric resistance-wire tensometers are being used, glued to the measuring element by means of epoxide cement.

The connecting spindles for the transmission of the torsional motion to the operating rollers are designed as pendulum-type claw couplings, in lieu of the conventionally used Hooke's coupling / Hooke's joint /. The geared roller mill distributing the torsional motion to the spindles is of a novel light-weight design / a Czechoslovak patent /.

The gear box of the main drive has been standardized and has gone into series production. The connecting spindle forming the link to the motors has been selected with a view to efficient planning, so as to make the best use of the premises of the rolling-mill plant proper and to reduce the noise in the rolling-mill plant, caused by the electric motors. Apart from the above said, the arrangement concentrates the electric sets in one room, a solution improving the possibility of supervision and maintenance of the electric equipment and facilitating the work.

The right-hand, as well as the left-hand winding equipment are provided with clamping drums. The drum shafts are supported in anti-friction bearings. The gear boxes of the winding drums are likewise of standardized design. Between the winding drums and the rolling mill three small rollers are arranged for the tensometrical measuring of tension. The tensometer is based on the principle of a magnetostriction, i. e. it utilizes the elongation of the mechanical component / the pull rod / for a change of the magnetic flux. The design of the elongation indicator is covered by a Czechoslovak patent and is a product of the national corporation Mechanopta in Kutua Hora.

A fork, controlled by means of a compressed-air cylinder is provided for the sliding-down of the coil from the drum of the winding device. The removal of the coils from the winding drums and their dumping to the right or to the left side of the rolling mill is performed by trucks, which are controlled by hydraulic-pneumatic cylinders. These trucks are located below the slide-in floor. For the maintenance of the thermal stability of the rolling mill a standardized emulsion system with a pump capacity of 400 liters / minute is used, equipped with filters for the purifying of the technological liquid / emulsion /, coolers, temperature regulators and heaters. The gear boxes are lubricated by a circulation system, fed by an oil distribution system with a capacity of 160 liters/minute. The anti-friction bearings and the fluid-friction bearings have their own oil distribution system. All these sets are placed in a common basement premises.

The electric governing drives and the regulating gear of the mill train are of a technically very advanced and challenging design, they are the result of the untiring assiduous efforts of our technical designers and based on an extensive pool of experience.

The reversing four-high rolling mill is driven by two direct-current electric motors, arranged in tandem, each electric motor having an output of 300 kW, series-connected and fed by dynamo with an output of 620 kW. The driving gear of the winding drums is similar, however, the output per motor is 200 kW. As source of power for the electric roller motors and for the electric motors driving the winding drums serves a Ward-Leonard speed-changing control system, consisting of three dynamos, each with an output of 570/620 kW, and driven by a synchronous electric motor, with an output of 1000 kW, 1300 kVA.

The adjustment of the rollers is automatic. The roller adjustment gear can operate in the following ways :

(a) Automatic adjustment with pre-selection. Seven selsyn generators grouped on the pre-selection panel permit pre-selecting of the roller positions, to be one by one successively actuated by pressing a push-buttons are provided, by means of which a correction of the adjustment can be performed once the rollers have assumed their position.

(b) Step-by-step adjustment. The rolling-mill operator selects, prior to each pass, by means of a selsyn generator located in the control box, the proper roller position to follow. As soon as he presses a push-

(Continued on page 120)

Indo-German Collaboration Gives India its First Major Photographic Industry

PHOTOGRAPHY is gaining popularity all over the world and Agfa has always been interested in taking every opportunity to foster its growth. In keeping with this, Agfa has extended its manufacturing programme to India. A start was made with the camera factory at Baroda in collaboration with New India Industries Ltd.

For the camera factory, Agfa of West Germany invited Indian technicians to study the precision manufacturing processes in Germany and also depute German technicians to initiate the manufacture of Agfa Cameras in India. At the Baroda factory, first to be produced are the Agfa Synchro Box Cameras which have an established reputation all over the world. In every respect these cameras are equal to those made in Germany, with the result that they have opened up an export market to earn foreign exchange for India. These Indian-made cameras are already exported to Europe, South America, Africa and South-East Asia. The very fact that an infant industry could compete with the industrially advanced nations of the West, and help to place India among the ranks of those countries able to export high-precision goods, is a unique achievement; one regarding which everyone concerned can well take pride in. The world-wide sales organization of Agfa with representatives in every country facilitates the export of Agfa cameras manufactured in India.

(Continued on page 121)

Agfa of Germany was founded by chemists and one of the main reasons for its great achievements over the years has been this favourable combination of photo-chemistry with photographic mechanics. Even today in their new Research Laboratory there is close co-operation between the chemical, physical and emulsion departments in the testing of new films, papers and multi-layer emulsions of colour films. This assures the steady and integrated progress of photography through systematic, painstaking research and development.

The same pattern will be repeated in India by New India Industries Ltd., whose factory is nearing completion in greater Bombay. This joint venture of Agfa and New India Industries will give India its first precision factory for the manufacture of photographic papers. When the new Agfa paper manufacturing plant goes into production next year, Agfa Photo products will go a long way to meeting India's requirements of basic photographic materials. Step by step India will manufacture an increasing number of Agfa products. Who can tell, but n a few years India may be among the largest producers of photo goods in Asia.

(Continued from page 119)

button the rollers will then move into the new, by him selected, position. Also this alternative permits the correction of the roller position by means of push-buttons, during the rolling process.

(c) Alignment of rollers. For the possibly necessary achievement of co-axiality of both rollers it is possible to readjust the position of one of the setting screws. The equipment for the adjustment of the rollers has been designed with a view to permit the installation of automatic regulating gear for the thickness of the strip.

Operation of the mill train requires the services of one rolling-mill operator and an assistant. The coil is conveyed either by crane or by electric battery truck to the uncoiling box and placed into it. The front end of the strip is introduced between the draw rollers, which then feed the strip to the rolls of the rolling mill. At an introduction rate of 0.5 metre/second the front end of the strip proceeds to the drum of the right-hand winding device, where the operator's assistant inserts it into the grove of the drum, clamping it fast in its place. After the small draw rollers have been released in the uncoiling box the rolling of the first equalizing draft takes place. The rolling direction is then changed and the end of the strip inserted into the drum of the left hand winding device. The further rolling process then takes its course in accordance with the pre-adjusted draft plan. Beginning with the second draft the rolling mill train will stop automatically after the finishing of each coil. The rolled-out coil is then shifted from the drum of the winding device onto a truck, which takes it to a distance of two metres from the winding device, dumping it there onto the floor of the rolling-mill plant.

The development of four-high rolling mills in the Czechoslovak Socialist Republic travels along a road towards increased mill-train outputs/ i. e. an increase of the number of the rolled products processed on the rolling mill train per time unit/, a road towards an ever-improving quality of the rolled product, and this as far as surface quality is concerned and likewise with a view to achieve the correct final dimensions of the product. Further mechanisation and automation of the rolling mill train are in the stage of development.

The reversing four-high rolling mill described above is being introduced on foreign markets by the firm of Technoexport, official Foreign-Trade Corporation for the export of complete industrial plants, in Prague 1, CSSR.

Specialization a necessity to realise the Third Five Year Plan

Development of specialised ancillary industries for augmenting India's Power Supply

OUTLOOK ON PLANNING TARGETS

WHILE the Five Year Plan placed emphasis on the development of Agriculture and the Second Five Year Plan on the development of basic Industries, the Third Five Year Plan envisages a large economic development through heavy industries. One guiding principle of the Indian economic policy which certainly cannot realise the planned programme without sufficient foreign aid, is a far-reaching utilisation of the resources to be obtained from a self-generating economy. In order to do justice to this guiding principle it is necessary to have abundant supplies within the country of raw materials of satisfactory quality from own resources, to keep down imports and to increase exports by all possible means. From this point of view we shall investigate in the following article taking for example the electrical industry, or strictly speaking, the example of some electrical insulating materials for the manufacture of electrical machines. This is based on the fact that production and utilization of electric energy are of great importance for the extension of various industries and for rural electrification as well.

IMPORTANCE OF INSULATION

The exact working of electrical machines and their efficiency is determined mainly by the quality of the insulating materials utilised. In this connection it can be pointed out that during the past 60 years the improvement of the ratio of weight to capacity of electrical motors from 30 kos x kW^{-1} to 15 kos x kW^{-1} or even to 9 kos x kW^{-1} for class-F-types with higher thermal stability has been made possible primarily by the supply of proper insulating materials. These figures show that with the same capacity lesser material consumption during production, lower costs on transport of the electrical motors and better utilisation of space for installation have been achieved. The insulating materials which made this possible are the wire enamels for the conductors, the impregnating varnishes and surface coatings for the windings and possibly impregnating, coating and casting resins.

The wire enamels have to afford sufficient insulation mutually between the turns of the same winding and also between the turns of different windings. The insulation has to withstand continuous influence of heat,

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(Continued from page 120)

moisture, mechanical stresses and chemical aggression. On the otherhand, the impregnating varnishes have to give an excellent bonding strength to the windings, to protect the insulation additionally against environmental influences and to improve heat-dissipation. The surface coatings are utilized in order to strengthen the protection obtained with the impregnating varnish in case of extreme environmental factors. The impregnating, coating and casting resins in principle have nearly the same functions as the varnishes and surface coatings. It must be taken, however, into consideration that they are solventless systems which allow improvement of the insulation and furthermore—because of a possible thicker coating—impart higher ability to withstand mechanical stresses.

REASONS FOR SPECIALIZATION

The above mentioned different functions show that, in view of the necessary properties and the processing of the products, a specialization on certain fields of application is indispensable. This may be the basis for the fact that in Europe—simultaneously with the extension of the electrical industry at the beginning of this century—**the insulating varnish industry has separated from the paint industry and has gone its own way for the benefit of electrical goods.**

It would be worth while at this stage to consider the necessity of further different types of insulating materials for particular fields of application. In order to arrive at a conclusion on this matter, the idea of a universal impregnating varnish shall be discussed. The necessity of a material which has to fulfill the functions of an impregnating varnish, does not include automatically the requirment for different types of impregnating varnishes. Without any further consideration of the background the opinion may exist that one type of impregnating varnish suffices to suit all purposes. An argument against this is already the fact that the mechanical performance of the impregnating varnish must be different depending on the type and service-conditions of the machine. The windings of a small high-speed armature need a strong mechanical bonding in order to protect them against centrifugal forces and to prevent the winding-heads from raising during operations. For this field of application it is, therefore, necessary to process an impregnating varnish which particularly must give excellent bonding in order to impart to the winding the necessary mechanical strength. In case of a big generator unit with relatively low revolutions, however, this factor is not so important as the stresses caused by centrifugal force can be neglected. It is far more important to observe the performance of the impregnated windings with regard to increased thermal expansion caused by higher copper and iron content. A hard baking impregnating varnish would not be in a position to withstand thermal expansion, but would crack and make the moisture-ingress into the interior of the windings possible thus endangering the life of the component. That means, however, that for this second fleld of application a very flexible impregnating varnish must be used which is in a position to compensate thermal expansion without damage to the film. These two examples show that in the practice of the electric motor construction contrary requirements arise which never can be met by the properties of just one insulating material. Thus the ideal of a universal impregnating varnish is carried ad absurdum.

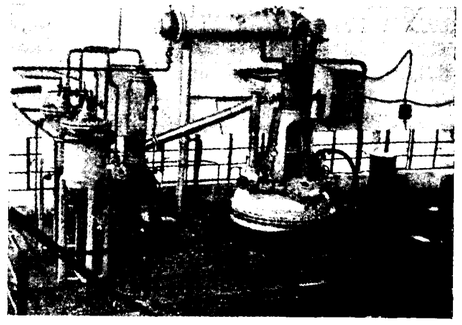
Dr. Beck & Co. (India) Ltd., in Pimpri/Poona near Bombay

The technically based impossibility of a universal insulation for a particular field of application, for instance impregnation, shows, however, that also for the same field of application different types that means in this case special types, are necessary. The extent of specialization, however, is growing with the existence of other fields of application as, for instance, enamelling of wires and coating of windings, particularly because within these other fields, special requirements again possibly have to be complied with. It is thought, for instance, of an enamelled wire with good burn-out properties which even in case of high heat development only scorches without effecting a break-down of insulation due to space-keeping achieved by the kind of residues. An enamelled wire with such properties, however, by no means can be solderable at the same time. As the conditions with coating lacquers for treatment of windings in principle are the same, it can be stated that for all fields of application mentioned a universal insulating material is unthinkable. A specialization is therefore necessary with reference to the different fields of application and also with respect to the special properties required within each particular field—depending on processing and service conditions—and their possible collision with contrary properties. To choose out of a great number of types the most favourable one with regard to the desired properties, to the prevailing working conditions and to give advice for its processing, is the matter of the application-technique.

The application-technique has to coordinate the wide range of products of a specialized manufacturer of insulating materials and the requirements of the customers. It even might become necessary either to adjust the material to the plants available or the latter to the material, in order to achieve a satisfactory result with a specific application problem. This could be explained by the case of enamelled wire production where enamelling machines with varying constructions are available. If, for instance, a type of wire enamel has been applied to the satisfaction of the consumers with horizontal machines and is in the future for some reasons to be processed on vertical machines, generally a change in solvents of the wire enamel will be necessary in order to adapt its viscosity to the new processing conditions. Advice for selecting the proper type under consideration of the properties of the insulating material and the plants available as well as assistance in case of possibly necessary adaptations need, however, degree of knowledge and experience which only specialists in the fleld of application concerned possess. Only they ensure a solution of an application problem which is satisfactory from a technical and economical point of view.

AVAILABILITY IN INDIA

The technically based necessity of specialization with regard to the properties of insulating material and its processing lead to the question whether or to what extent such materials are available in India. In this connection the joint Indo-German company of Dr. Beck & Co. (India) Ltd. may be mentioned. This firm is producing wire enamels, impregnating varnishes and resins especially for the electrical industry. Dr. Beck & Co. (India) Ltd. was founded in 1956 and has shown a satisfactory development. Now the main products of the German partner, the Dr. Beck & Co. GmbH., Hamburg, which since 1904 exclusively is specializing on the indicated material groups, are available in India out of its own production. Thus there is not only offered the technical advantage that special products can be obtained which are favouring life and efficiency of electrical components manufactured for Indian demands, but also enables to achieve a high standard of quality as determined in the world market by the highly industrialized countries. Equal quality, however, is absolutely indispensable in order to be competitive on the world market, especially in view of the fact that the highly industrialized countries will endeavour to export to the new independent nations of the African



Partial view of resin section of Dr. Beck & Co. (India) Ltd.

Continent, for instance, in order to fully utilize their large capacities. These countries, however, also are very essential from the point of view of India's export. Apart from the improvement of quality by using special products which is important for export Dr. Beck & Co. (India) Ltd. offers the advantage that, as already indicated, their products are manufactured primarily in India. Thus independence from imports is obtained which is again an aim of the Five Year Plan.

OWN PRODUCTION BY CONSUMERS

Dependence on imports in principle, of course, can also be minimized by the consumers of insulating materials by producing the materials themselves for their own use. First of all it must be considered that internal production for the demand means that competition indirectly is taken up with a specialized firm. The latter, however, is in a position to carry out on a large scale extensive and detailed research and development work which forms the product. Furthermore it must be realized that the specialized company can give advice for the solution of application problems because of the current contact with the electrical industry. The " know how " thus at disposal cannot be obtained out of own practice by a firm which stands on its own. That means that a firm producing insulating materials for own demands can take part only in a very restricted way in the technical progress and that it, probably, tends to endanger its market position, if it does not cooperate with a specialized firm. Even in case of own research and development works, the whole situation would hardly be better. To the expenditures for the installation of production plants and control devices those for building and running laboratories must be added. Regarding the fact that the probability of a positive result of research and development work in the industry is rising with increasing means, there is only little chance for positive research and development work on a sector for the consumer of the respective special articles, particularly if work must be done on a field to which the firm concerned is not familiar. This also shows that the technical and personnel conditions are likely to be poor. The means which are necessary for successful activities are normally underestimated due to lack of experience. The negative result of own research and development work which will have to be expected does not only mean that capital expenditure has been wasted but also includes that the quality of the sales products has probably decreased in comparison with competing firms which are in contact with specialized suppliers, especially as there exists the tendency to utilize technically not satisfactory materials, in order to justify the research and development work. In principle a research and development risk arises ranging in its consequences from wrong investments to endangering the market situation. Therefore it would be more advisable from a technical and also from an economical point of view to apply products and utilize the experience of a specialized firm. Thus the continuous contact to technical prog ress is ensured.

Regarding prices the products of a specialized firm probably might be a little more expensive than the materials out of own production. Even if one does not consider the research and development cost saved when purchasing from specialized firms, the eventually somewhat higher price always can be justified as a " risk premium ". Furthermore it must be added that, when trying to determine the economy for own insulating material production, in most cases only the direct costs which easily can be ascertained are considered, while the overheads are neglected. The result of such a calculation, however, at any rate is highly doubtful.

CONCLUSION

The question raised at the beginning what possibilities there are in order to improve self-sufficiency of the country under relief of imports and increase of exports and thus to help to realize targets of the Five Year Plan, consequently must be answered at least with reference to the example of some insulating materials important for the electrical industry, with the necessity of specialization. The small example which in its technical depth by no means could be described thoroughly, has shown a variety of aspects for specialization regarding the product and its application and a far-reaching economical importance for a firm and for the country as well. The question crops up, whether only a particular case has been touched upon or whether the normal degree of necessity for specialization has been treated. Comparative analysis will make it obvious that the standard of specialization has attained in highly industrialized countries which by the way is still rising, should be aimed at in order to achieve further increase of economy, in developing countries.

The Heat Consumption practically obtainable, and the stage of efficiency reached by the HUMBOLDT Rotary Kiln with Gas Suspension Heat Exchanger

By A. Hoga, West Germany

INTRODUCTION

SINCE publishing the first experiences gained with gas-suspension heat exchangers in this publication in 1954 (1) giving, at the same time, pointers to the further development of this cement burning process, this article will now deal with the position as regards performance at the present time.

Threshold values for the thermal requirements for this process have been worked out by others in various publications (2, 3, 5 and 7), and although these theoretical values cannot be reached to simply by the technical means at hand at present, they have nevertheless already been very closely approached in actual practice. This has only been made possible by constant investigation and improvement of heat exchanger plants.

With the first plants made (1) the consumption of heat was between 910 and 1,028 kcal/kg (kilogram-calories per kilogram) of clinker, but nowadays values

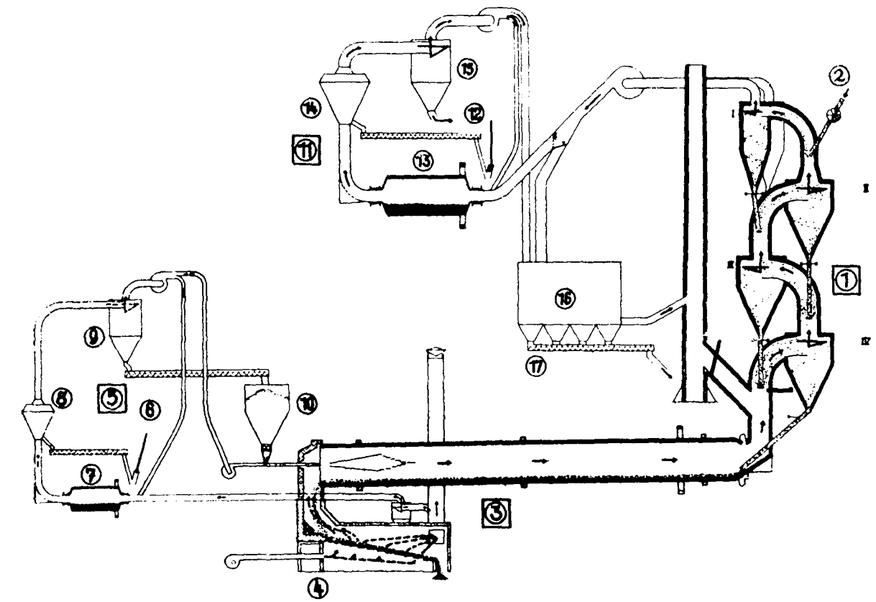


Fig. 1

1 Heat exchanger plant with 4 stages (I-IV)	6 Raw coal feeding	12 Raw material feeding
2 Raw-mix feeding	7 Coal mill	13 Raw material mill
3 Rotary kiln plant	8 Air separator	14 Air separator
4 Inclined grate clinker cooler	9 Cyclone	15 Cyclone
5 Coal grinding plant	10 Coal dust bin	16 Filter
	11 Raw material grinding plant	17 Dust return

Arrangement of HUMBOLDT rotary kiln with heat exchanger operating in connection with mill for grinding and drying raw materials

between 760 to 780 kcal/kg of clinker have already been obtained by a steady use (7). The limit technically obtainable now would appear to be about 750 kcal/kg of clinker when burning a crude material with 77.5 to 78.5 $CaCo_3 + MgCO_3$.

The writer had already recommended in 1954 (1) making use of the waste gases from the heat exchanger for drying the raw material, and as this has since become a matter of course, it will be dealt with still further; Heat consumption and kiln performance are dependent on various factors and so it would seem as well to consider these more fully. Furthermore, a report will be made on the present position of dust removal from the kiln installation.

HEAT EXCHANGER DESIGN

A primary essential for heat consumption is the number of cyclone stages.

Installing even only one stage already results in a heat economy of some 25% compared with a normal kiln and with a four-stage heat exchanger this rises to over 40%. The standard type is the four-stage heat exchanger, as further increasing the number of stages no longer results in any appreciable advantages.

A point to consider is whether or not to have three stages where the raw material has a high percentage of moisture, as in that case the greater quantity of waste heat could again be used for drying.

A degree of de-acidification of the raw material exceeding 40% has already been obtained with four-stage heat exchangers; any very much higher preliminary de-acidification in the heat exchanger is not desirable and for that reason also four stages are ample. Fig. 1 shows schematically a rotary kiln with a four-stage heat exchanger.

THE EFFECT OF HEAT LOSSES

Waste gas losses in the heat exchanger increase as the thermal losses rise in the kiln plant.

Eigen (3) splits up the thermal losses in the plant into those of the main and secondary systems, assuming the boundary between the stystems to be the point in the plant where the raw material has a temperature of 550°C. (Commencement of de-acidification.)

Losses in the main system are made up of :

1. Losses in the cooler (clinker waste heat, cooler used air and radiation).

2. Radiation from the kiln, also from the part of the heat exchanger extending to the boundary of the system.

In the smaller kiln plants heat losses in the main system may amount to as much as 260 kcal/kg of clinker ; with large kilns the heat loss in the main system is lower, owing to the smaller radiation area in relation to clinker production, though practically it can hardly be lowered beyond 160 kcal/kg of clinker.

The so-called loss multiplier shows by how many times the total loss of the plant increases with a rise in the losses in the main system ; this multiplier is not a set figure, but again depends on various factors. With heat exchanger furnaces or kilns it varies in value somewhere between 1.5 and 1.65 which therefore means that a rise of about 100 kcal in the main system heat loss will cause an increase of some 150 kcal at least in heat consumption.

Measures for reducing losses in the main system are, inter alia backing-up the lining of the kiln with refractory brick, or the use of light firebrick with a low thermal conductivity in the calcining zone of the kiln, as well as bringing the nozzle forward in the kiln, so that the clinker is pre-cooled in it prior to entering the cooler.

THE EFFECT OF THE SIZE OF THE KILN

Larger furnaces or kilns have lower radiation losses than smaller ones in relation to throughput, so that size must always be taken into consideration when comparing heat consumption figures.

Table 1 shows approximately how heat consumption varies with the size of the kiln, three standard sizes of kiln being compared with one another. It will be seen that the medium-sized kiln already takes some 50 kcal/kg more heat, and the small kiln some 100 kcal/kg of clinker more heat than the large one.

The excess-air factor behind the heat exchanger is assumed equal for all three sizes of kiln since, on the

one hand, the large kiln must be run with a higher air excess than the small one, owing to the lower heat consumption, while on the other hand, however, there is a lower admission of infiltrated air per kg of clinker with the large kiln.

As the kiln increases in size, so the heat consumption is reduced and with it the quantity and temperature of the waste gases of the heat exchanger also. As the pressure losses in larger plants are also lower, the power required for the induced draught fan per kg of clinker will be more than 30% lower for larger plants than for smaller ones.

The kiln outputs given in Table 1 are normal ones, which means that the output from the kilns can still be raised by as much as 10% more. Plans for new plants should be worked out on the basis of only 90% of the normal output, so as to have a certain reserve.

Already rotary kilns with heat exchangers are working with results up to 1000 tons. All kiln plants are equipped with combinated grinding and drying mills or rotary dryers, which were heated by the waste gases from the heat exchanger. Dust will be removed by electrostatic filters. Kilns can be built up to 1500 tons.

THE EFFECT OF THE LENGTH OF THE KILN

The normal length of present-day heat exchanger kilns is 15 to 16 times the inside diameter of the kiln, though this does not represent a definite figures, that is to say, there is no so-called model size or scale for rotary kilns with heat exchangers.

Wall losses per kg of clinker are rather higher for long kilns than for short ones, in the normal way, though these losses can be minimised to a great extent by good insulation of the calcining zone of the kiln.

In long kilns part of the preliminary de-acidification of the raw material that would otherwise take place in the heat exchanger takes place in the kiln, causing the waste gas temperature at the kiln inlet to drop, though the waste gas temperature at the heat exchanger remains about the same as for a short kiln, because the heat of the gases transmitted to the raw material is lower in the heat exchanger on account of the lesser preliminary de-acidification.

If a long kiln cannot be well insulated the heat loss of the main system will rise and consequently the heat consumption with it. In that case, the waste gas temperature of the heat exchanger of a long kiln is then higher than with a short one, unusual though it may seem.

Proof of the fact that relatively long kilns can also be operated with heat exchangers is given by the data shown in Table 2 for a kiln 2.8 metres in diameter and 51 metres long fitted with heat exchangers. The numerical values for working the kiln with heat exchangers were found by a neutral observer during a 48-hour test. The kiln tested has a widened sintering zone and a drum cooler 2.6 to 2.8 metres in diameter and 21 metres in length.

As the rotary kiln was an old one, the data for a test carried out shortly before conversion, i.e., when working without a heat exchanger, are likewise given in Table 2.

The waste gases from the heat exchanger for this kiln were used for drying the raw material for this kiln with approximately 390 tons per 24 hours throughout as well as for a Lepol kiln lying next to it with a clinker output of some 300 tons per 24 hours. In the rest 167 kcal per kg of clinker were regularly passed to the drying plant with the waste gas from the heat exchanger. As the drying plant, like the rotary kiln, is in operation 24 hours a day, the net amount of heat required purely for cement burning at the present time is 832—167 = 665 kcal per kg of clinker. As will be seen, placing the heat exchanger into service resulted in an increase in output of 73% and a reduction of the heat consumption by about 48%, i.e., almost half. The heat recovered by waste gas drying has not been taken into consideration in this.

COOLERS

There are heat exchanger kilns in operation both with grid and also drum coolers. Satellite tubular coolers are unsuitable in most cases.

With a practical size and correct design heat losses are about equal for both grid and drum coolers as well, though the grid cooler has the advantage of delivering cold clinker. Under like conditions and with a heat requirement of 800 kcal/kg of clinker, the clinker from a drum cooler will be at a temperature of 250—300°C. A further advantage of the grid cooler is the absence of a seal at the head of the kiln.

Bringing the combustion nozzle as far forward in a rotary kiln as possible is an important point with both cooling systems, so as to cool off the clinker somewhat

already in the kiln tube. Burning on the edge of the kiln tube the clinker produced in the cooler is at a temperature of some 1,350°C., but with the combustion nozzle moved forward this temperature can be reduced to under 1.200°C. Through this the Temperature of the secondary air is also lowered, so that the head of the kiln with its seal and the outlet end of the kiln tube are all protected.

Hot air for drying the coal can be drawn off better from a grid cooler than from a tubular cooler. With the latter, there is only air at a very high temperature available, and it is more economical to feed it to the kiln as secondary air.

Recovery of the waste air from the coal dryer or the coal mill in the rotary kiln, as the case may be, is not a practical arrangement, as it is only ballast owing to its low temperature, so that it reduces the flame temperature and increases the heat consumption of the kiln.

EXCESS AIR AND INFILTRATED AIR

The lower specific heat required by a rotary kiln is, the higher the excess of air for combustion must be. With too low a quantity of air for combustion the heat recovery from the clinker in the cooler is too bad, or the flame temperature rises too greatly with the secondary air too hot.

The proportion of primary air to combustion air must not exceed 10% to 15%, and warm air up to 150°C. can be taken from the grid cooler for this, though this arrangement does not result in any great saving in heat.

With a heat consumption of 750 to 850 kcal/kg of clinker the excess air for combustion must be at least 15%, which means that an 0_2 content of a least 2.5% must be shown at the kiln inlet by measurement.

The excess air at the induced draught fan is higher, as a result of the infiltrated air entering at the inlet seal of the kiln and also of the slight leakages at the heat exchanger.

As air infiltrating at the kiln inlet at the temperature of the external air mixes with the kiln gas at about 1,000°C. still before the system boundary, it causes an appreciable thermal loss. For each 0.1 Nm^3/kg of clinker infiltrated air increases the heat consumption mathematically about 34 to 38 kcal/kg of clinker. In addition, infiltrated air increases the amount of gas to be delivered by the induced draught fan, and consequently the power required.

With heat exchanger kilns of earlier construction an intake of infiltrated air of 0.2 to 0.3 Nm^3/kg of clinker was found, but just recently kilns have been fitted with a new inlet seal which ensures practically complete exclusion of air. The anticipated saving in heat consumption with this improved sealing was actually established with the new plants.

WASTE GAS UTILISATION

Table 1 also gives information with regard to the possibility of drying the raw material needed for the kiln by the waste gases from the heat exchanger. In the case of small kilns, raw material containing up to 8.5% of water can be dried by the waste gases, but in a large kiln the heat of the waste gases is only sufficient for drying raw materials containing 6% of moisture. The heat recovery possible by waste gas drying is from 128 to 95 kcal/kg of clinker, all according to the size of the kiln.

The actual saving in heat can only be established, however, by comparing it with drying raw material by separately-heated dryers with their own waste gas and firing losses. In this case the saving in heat can amount to 170 to 125 kcal/kg of clinker (see Table 1).

Table 3 gives the fuel costs for a figure of 200,000 tons annual output with direct-heated dryers where the raw material contains 6% of water and the coal 10%.

Unfortunately, the fact is often overlooked that the heat expenditure for drying in the case of the heat-economising rotary kiln plants amounts at least to 15% of the heat consumption of the kiln. The fuel needed for this can be saved by drying with waste gas heat.

The coal is best dried by the air from the grid cooler; the quantity of heat from this air is so great as in most cases to be ample, even with the coal grinding plant running only for eight hours a day.

Using air from the cooler for drying the raw material is not recommended with heat exchanger kilns, owing to its low heat content and the fluctuating temperature.

FINENESS OF THE RAW MATERIAL POWDER

It has been found with rotary kilns with gas-suspension heat exchangers that the powdered raw

material can be fed in a more coarsely-ground state than when burning granulated raw powder without the clinker quality being worse than with the latter process.

Thus, in plants in the cement district of Beckum heat exchangers have been charged with a raw powder consisting of marl with about 74% $CaCO_3$ with added limestone having some 95% $CaCO_3$. An extremely high-quality clinker was produced with a raw powder fineness of 20% residue, screen 0.09 mm. In the burning process with granulates this material had to be ground down to 10—12% residue, otherwise the proportion of free lime in the clinker is too high and, in addition, a coarse raw powder granulates badly. The coarser grinding saves the Works a powder requirement of about 2.5 kwh per ton of raw powder or 4.0 kwh per ton of clinker. Despite a relatively coarse raw powder with the heat exchanger kiln the percentage of free lime in the clinker still remains lower than when burning granulates from considerably finer powder under otherwise like conditions. Clinker from heat exchanger kilns only has about 0.5% free CaO as a rule.

CLINKER QUALITY

Ruppert (6) had already discovered in 1955 that the strength of cement from heat exchanger kilns was about 10% to 15% above that of a kiln charged with granulated material in the same Works. The reason appears to be chiefly in the some 1% higher percentage of free lime found in the latter. The same thing has been observed in other Works also.

Thus, in one plant after installing a heat exchanger the fineness of the cement was able to be raised from 6.6% residue on screen 0.09 mm to 10.7% on the monthly average the strength still being some 5% higher than formerly.

The more difficult grindability of the clinker from heat exchanger kilns noticed by Ruppert has not been noticed in other Works, comparisons of grinding having shown even a considerably less power requirement in some cases. This is also apparent from the comparison of the grindability figures given in Table 2 for a rotary kiln with and without heat exchanger operation.

A remarkable thing in this comparison is that the increase in better grindability rises appreciably with the increase in ultimate fineness. With heat exchanger operation the clinker is 14% better grindable at 2500 Blaine and over 30% better grindable at 4500 Blaine.

REMOVAL OF DUST FROM THE WASTE GAS

The cyclone dust recovers fitted to the first plants were not always adequate, as the places where the plants were installed set special demands on dust ejection in each case. Meanwhile, plants equipped with fabrik filters or dust extractors of the wet type were also built. Both dust-removal systems give a really high degree of purity to the waste gases. One disadvantage of the fabric filter is its high resistance and consequently high power requirement of the dust-removal plant, as well as its liability to breakdown

Dust removal by the wet process certainly requires somewhat less power and lower investment costs, though removal of the resulting sludge imposes difficulties generally.

The bast results obtained so far have been with a series of the electrostatic filters fitted in the meantime (4) and nowadays a degree of dust removal of very nearly 100% is obtainable where they are suitably designed and arranged for the purpose. This applies at present both to hot, dry waste gases from the heat exchanger, as well as to moist gas at 80—100°C. that has already dried the raw material.

Local regulations have to be complied with in connection with demands on the degree of dust removal by a filter. As the technical position is to-day, practically complete removal of the dust from waste gases is possible by electrostatic filters, and so some places already stipulate a maximum dust discharge of 0.1% of the quantity of clinker. Accordingly, the absolute dust discharge from such plants amounts only to a few kilograms an hour.

Table 4 gives the results of measurements taken on existing filter installations after the heat exchangers.

In utilising the waste gases from the heat exchanger for drying the raw material in dryers or grinder-dryer plants, the filter is used for removing the dust from these installations at the same time. The size of present-day drying plants calls for filter units already very large in themselves, for removal of dust from their waste gases.

Even though fabric filters behind the drying plants call for somewhat lower investment outlays, the electrostatic filter is nevertheless superior to them economically, with gas quantities over 30,000 cubic metres per hour (m^3/h), the reason for this being

the high restistance of their fabric filter—100 to 150 mm column of liquid—and the power required in connection with it compared with the 5 to 10 mm column of liquid only, with the electrostatic filter. Maintenance and service costs are also considerably lower with the latter.

In actual practice, the effective quantities of gas that dust has to be removed from, working with or without waste gas drying, is about the same.

Dust-arrester systems for directly-heated raw material dryers can be made up to 50% smaller owing to the higher entering temperature of the gases with the same throughput. Considering, though, that the directly-heated dryer or grinder-dryer plant is not in operation the whole day and that the costs of enlarging a dust-arresting system do not rise in proportion to the quantity of gas, then it can be said that the costs for removal of dust from waste gases should be added at the rate of 40% at most to the heat exchanger kiln and at least 60% to the raw material drying plant.

SUMMARY

The Humboldt rotary kiln with heat exchanger has made considerable headway since its original design, the heat consumption having been brought down from about 1,000 to less than 800 kcal/kg of clinker.

In the case of kilns with a large output the practical limit of the gross heat requirement would appear to be in the region of 750 kcal/kg of clinker.

A net consumption of 650 kcal/kg of clinker may be reckoned with for cement burning when using the waste gases from the heat exchanger for drying the raw material.

Dust discharge can be kept down to a limit of less than 0.1% of the quantity of clinker produced by using electrostatic filters.

Cement from heat exchanger kilns has so far shown higher strength than that burned from granulated raw material powder in rotary kilns.

Generally speaking, clinker from heat exchanger kilns contains less free lime than clinker from granulates, and this also applies if the raw powder material is ground considerably coarser. In this way up to 4 kWh/t of clinker can be saved in preparation of the powdered raw material.

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TABLE 1

The effect of the size of kiln on heat consumption quantity of waste gas, waste gas temperature, and the possibility of drying the raw material by waste gases from the heat exchanger.

Kiln size, tube dia./length	meters	2.6×34	3.2×43	4.0×58
Rated clinker output	tons per 24 hrs.	230	400	770
Heat loss in main system of kiln	kcal/kg of clinker	250	220	190
Gross heat consumption	kcal/kg of clinker	850	800	750
Quantity of waste gas at blower, (n = 1.35)	Nm^3/kg of clinker	1.60	1.52	1.45
Waste gas temperature of heat exchanger	°C.	340	320	300
Waste gas heat per kg of clinker	kcal/kg	188	168	150
Possibility of drying raw material for the kiln by waste gases				
Max. water content in raw material	%	8.5	7.3	6.0
Heat required for drying without waste gas loss	kcal/kg of clinker	128	110	95
Dryer waste gas heat	kcal/kg of clinker	60	58	55
Infiltrated air plus H_2O from dryer	Nm^3/kg of clinker	0.65	0.63	0.60
Dryer waste gas quantity	Nm^3/kg of clinker	2.25	2.15	2.05
Dryer waste gas temperature (20°C)	°C	100	100	100
Net heat consumption, with waste gases fully utilised	kcal/kg of clinker	722	690	650
Extra consumption for drying raw material by directly-heated dryer	kcal/kg of clinker	170	148	125

TABLE 2

Alterations to a rotary kiln installation by subsequent installation of a heat exchanger.

Inspection of rotary kiln plant		Nov. 1957	Oct. 1958	Alteration
Plant without or with heat exchanger		Without	With	in %
Size of kiln, tube dia./length	meters	2.8×51	2.8×51	
Sintering zone increased to	meters	3.36	3.36	
Drum cooler, tube dia./length	meters	2/2.6x21	2.6/2.8x21	
Clinker output from kiln	tons per 24 hours	226.3	390.4	+73%
Specific kiln output	tons per cubic metre per 24 hrs.	0.88	1.52	+73%
Heat input of rotary kiln gross heat consumption)	kcal/kg of clinker	1592	832	%−48
Quantity of waste gas per kg of clinker	Nm^3/kg	2.30	1.75	−31.8%
Waste gas temperature	°C	840	349	
Quantity of heat, waste gas, heat exchanger	kcal/kg of clinker		185	
Of above for drying raw material	kcal/kg of clinker		167	
Direct into electrostatic filter	kcal/kg of clinker		18	
Waste gas dryer in operation			2	
Drying drum dimensions, diameter by length	metres		2×20	
Throughput of both dryers	tons per hour		47.6	
Initial moisture of raw materials	%		4.5	
Raw material dried per kg of clinker	kg/kg		2.93	
Net heat consumption	832–167 kcal/kg of clinker		665	
Specific power requirement for grinding clinker				
Grinding fineness :				
2.000 cm^2/g (Blain)	kWh/ton	20.5	17.5	−12.5%
2.500 cm^2/g ,,	kWh/ton	27.5	23.5	−14%
3.000 cm^2/g ,,	kWh/ton	36.5	29.5	−19%
3.500 cm^2/g ,,	kWh/ton	47.5	36.5	−25%
4.000 cm^2/g ,,	kWh/ton	61.0	44.5	−27%
4.500 cm^2/g ,,	kWh/ton	78.0	54.0	−30.8%

TABLE 3

Cost of drying raw material and coal for an annual production of 200,000 tons of clinker.

Water content of raw material	%	6
Water content of coal	%	10
Heat required for drying raw material	kcal/kg of clinker	125
Heat required for drying coal	kcal/kg of clinker	15
Total heat required for drying purposes	kcal/kg of clinker	140
Heat consumption of rotary kiln, assumed	kcal/kg of clinker	850
Total heat consumption of plant	kcal/kg of clinker	990
Heat required for drying as percentage of rotary kiln requirement	%	16.5
Heating coal for drying, per annum, (7.000 kcal/kg)	tons	4000
Price of coal per ton (assumed) :	D-Marks	75.—
Fuel costs for drying only	DM per annum	300,000.—
Fuel cost for drying raw material and coal	DM per ton of clinker	1.50

TABLE 4

Results of measurements on various electrostatic filters behind heat exchangers.

Plant Filter placed behind		N Dryer	B Dryer	H Heat exchanger	K Heat exchanger
Effective quantity of gas through filter	m^3/h	55800	62500	51600	62900
Gas temperature at filter	°C	109	98	305	294
Quantity of gas through filter	Nm^3/h	39900	44500	24000	30700
Clinker output of rotary kiln	tons per hour	16.3	14.3	14.4	16.0
Quantity of gas per kg of clinker	m^3/kg	3.33	4.37	3.58	3.93
Quantity of gas per kg of clinker	Nm^3/kg	2.45	3.11	1.67	1.92
Dust content of crude gas	g/m^3	47.2	31.2	24.5	33.2
Dust content of crude gas	g/Nm^3	66.0	43.8	52.0	56.2
Dust content of purified gas	g/m^3	0.082	0.17	0.054	0.165
Dust content of purified gas	g/Nm^3	0.11	0.238	0.117	0.339
Dust discharged	kg per hour	4.54	10.6	2.8	10.4
Filter degree of separation	%	99.82	99.5	99.8	99.5
Dust discharge in relation to clinker production	%	0.028	0.074	0.019	0.065

Strojexport Corporation's Chief Addresses The Bombay Press

Mr. Eduard Muricky's Analysis of Strojexport's Co-operation with India's Industrial Development

Mr. Eduard Muricky, Director-General of Strojexport Foreign Trade Corporation, Praha, Czechoslovakia, who is now in New Delhi in connection with the Indian Industries Fair made a flying visit to Bombay, to meet Industrialists and other businessmen in the city. He addressed the Bombay Press at a special conference called at the residence of Mr. J. Roskot, Dy. Trade Commissioner for Czechoslovakia in Bombay on the technical collaboration between the Indian Industrialists and his organisation Strojexport. Here is a brief text of his address :–

THE Foreign Trade Corporation of Strojexport is a representative of the extensive and modernly equipped complex of Czechoslovak engineering works. It is the sole exporter of machines and machinery equipment of world-known marks of SKODA, CKD, TATRA, SIGMA and other which came into existence after the Second World War. These highly efficient and first class products have established for themselves a firm position in world engineering. Apart from individual machines, such as oil engines, machines for power engineering, food processing machines, building construction machines and road building machines, pumping machines and compressors, valves and fittings, gear boxes and speed variators, handling and hoisting equipment, and transport vehicles, the exports of Strojexport include also the fitting out of complete industrial plants, such as flour mills, brick factories, pumping stations, water purification plants, diesel power plants, etc. The Foreign Trade Corporation of Strojexport exports the products of 117 Czechoslovak factories to more than seventy countries of all continents, where it has its representatives and agents, technical centres and individual technicians, whom it has in thirty countries. On the customer's request it works out and supplies schemes for the delivered equipment. The essentials which are taken into account during the manufacture include, inter alia, the ambient climatic conditions in which the machine is going to operate. Strojexport provides, moreover, erection of the delivered machines by expert technicians and fitters who train local workers at the site for the correct attendance to the machines.

For the developing Indian industry the deliveries of machines and machinery equipment from the Czechoslovak Socialist Republic are likely to be of considerable importance. Business with India is carried on on the basis of mutual cooperation and affords advantageous conditions for both parties. If the total volume of Strojexport's exports in 1958 is taken as a basis the exports to India present the following picture :

1958	100%
1959	212%
1960	270%
1961	370% (estimate according to the volume of contracts concluded upto the present.)

A considerable proportion of Strojexport's exports of machines to India is occupied by deliveries of SKODA Diesel engines and diesel sets which serve for generation of electric power and for driving various industrial equipment.

A great interest has been shown in recent years in heavy sets of outputs of 550 kVA, 700 kVA and more. The interest of the Indian customers has also been focussed on flour mill machines, the largest of the flour mills of a capacity of 200 tons in 24 hours being installed in New Delhi.

The extensively developed industry in the Czechoslovak Socialist Republic and the rich tradition of Czechoslovak technicians and workers afford the possibility of manufacturing even the most complicated equipment. In 1959 harbour cranes of a capacity of 8 and 13 tons were delivered to India and erected. These operate in Madras. For building purposes Strojexport has supplied this year a considerable number of up-to-date and efficient type Ry-1 excavators. At Kangsabati (Bengal) a goods ropeway has been in operation since 1959, which handles building materials for the dam which is under construction there. At the beginning of next year the operation of one trolleybus line in Bombay will be started, for which Czechoslovak trolleybuses of the type 9TR will be delivered this year.

The cooperation with the Indian customers is not limited to a purely commercial basis, but Strojexport also provides—within the scope of the effected deliveries—effective service and technical aid of Czechoslovak technicians during the putting of complicated machines into operation and during the preparation of schemes for new equipment. The constantly developing heavy industry, precision engineering industry and economy of the Czechoslovak Socialist Republic, supported by a long tradition of Czechoslovak workers and technicians, provide all the prerequisites for a steady increase of Strojexport's share in the volume of the commercial agreement with India, with a view to the requirements of the Indian engineering industry in the 3rd Five-Year Plan.

According to the preliminary estimate it is assumed that the exports of machines and machinery equipment to India will be 25% higher in 1962 than in 1961. Continued exports of the traditional commodities, a widening of the range of the exported products and introduction of new commodities, such as equipments for surface treatment of machines, brick factories, pumps, ropeways, building and other machines, are reckoned with for the future. For this suitable conditions were created by the conclusion of the agreement concerning payments for goods in Rupees between India and the Czechoslovak Socialist Republic, which makes it possible for the Indian importers to purchase the necessary equipment in the Czechoslovak Socialist Republic easily. At present Strojexport is carrying on negotiations with some Indian firms, concerning the introduction of production under Czechoslovak licence, which means a deepening of the existing commercial and technical cooperation.

CAST-IN-PLACE PIPE FOR IRRIGATION

Program of water conservation on Salt River Project makes extensive use of monolithic concrete pipe cast directly into trench. Tests proved product adequate, and experience with laying 20 mi. develops field procedure and costs.

By H. Shipley
Assistant General Manager
Salt River Project, Phoenix, Arizona

AS part of its water-conservation program the Salt River River Project has been alert to any new method for saving losses common to unlined earth ditches. Water is so vital to the future of this irrigation system that concrete lining and use of concrete pipe have been subjects of constant engineering study and field testing. Most recent development in this program of reducing conveyance losses has been the extensive installation of monolithic cast-in-place concrete pipe. Since October 1955 more than 21 mi. of this type of pipe, commonly referred to by its trade name of No-Joint pipe, has been installed. Our methods, test results, and field operations are being presented in this article to add to the available literature on the conserving of the West's most valuable material resource.

A WORD ABOUT THE PROJECT

The Salt River Project is the oldest multiple Reclamation Project in the United States and one of the most successful, having paid off its original debt of $ 10,000,000 in 1955. It was originally dedicated by Teddy Roosevelt in 1911, and agricultural revenue derived since that year amounts to $ 1,000,000,000

(Continued from page 134)

while the Federal Income Taxes from this enterprise have netted approximately $ 335,000,000.

This irrigated oasis is in the hearty of Arizona's Maricopa County and envelops the fastest growing city of the United States—Phoenix. Originally, this irrigated area contained 242,000 ac., but to date it has lost some 42,000 ac. to subdivisions, industry and highway construction.

During World War II, irrigation and farming enterprises did very little improvement work due to low priorities assigned such projects. Recently, Congress recognized that these older Reclamation projects had to rehabilitate and modernize their facilities. Therefore, pursuant to the Act of Congress approved June 17, 1902 (52 Stat. 388), acts amendatory and supplementary were approved October 7, 1949 (63 Stat. 724) and passed by Congress which provided interest free loans for this purpose.

Under the guidance of the Phoenix office of the Bureau of Reclamation, the Salt River Project embarked on rehabilitation program in 1950. Construction of new structures, placing of concrete and gunite lining, and installation of concrete pipes were the three main objectives. Due to the cost of precast pipe, that particular facet of the program was relegated to play a minor role. However, pipe became a major project with the introduction of the monolithic cast-in-place concrete pipe.

Reasons for the installation of concrete pipe in the irrigation water-ways, or laterals of the system are :

1. Conservation of water, a very precious commodity in Arizona.
2. Maintenance of the old earth ditches was becoming very costly due to the hand labor required to clean inaccessible reaches.
3. Increased road widths conflicted with original ditch right-of-way.
4. Urban development demands that laterals be covered for safety of children since the new residents are not familiar with irrigation facilities and practices.

As mentioned previously, the installation of concrete pipe was not an active project. However, after a visit to Yuba City, Calif., where we observed an installation by Gilbert D. Williamson, the founder of No-Joint, we knew that if the physical properties were as reported, this type of pipe was destined for the Salt River Project. Bert M. Pringle, our vice-president, is a retired construction man and farmer in the valley, and was one of the members who made the trip. After observing 30 min. of No-Joint installation he said " Let's buy a machine and go home and go to work."

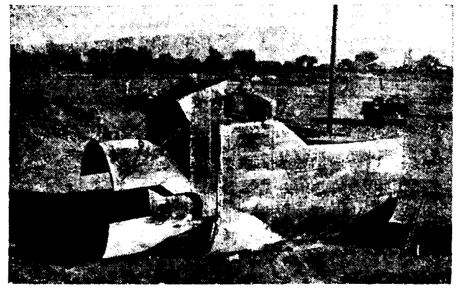
Two machines were ordered, a 30-in. and a 42-in. In order to be sure that this pipe would perform satisfactorily in this area, we planned a 200-ft. test section. With the assistance of Bill Adair, field engineer of the U. S. Bureau of Reclamation, test

General view showing construction of 48-inch No-Joint Concrete Pipe on curve—Swanston Estates Residential Tract, Sacramento

procedures were set up. Tests were also made under the same conditions with precast reinforced concrete pipe and plain pipe. Methods for the making the test and the results obtained are reviewed as a feature of this article.

It is realized that the result of one test is not conclusive, but along with test results obtained by Ernest C. Fortier, consulting engineer of Fresno, Calif., we were very confident that the installation of No-Joint was ideal for the soil conditions that exist in 90% of the Salt River Valley.

At the inception of the No-Joint program, a custom-made trenching machine was brought from California. This Butcher Trencher was very satisfactory but for irrigation operations was too specialized a piece of equipment. By the time our thired mile of monolithic pipe was installed, our engineer, Dick Juetten, designed a shaping bucket



View of electrically operated No-Joint machine for constructing 60-inch Dia. No-Joint Concrete Pipe. Machine moves to right, extruding pipe to left.

for our most versatile piece of equipment—the Gradall. We have seven of these machines operating on the project on maintenance and construction.

Other than the No-Joint pipe machine, the rest of the equipment is standard, such as a dozer, grader and water truck. Arizona Sand & Rock Co. delivers the 6-sack concrete ready-mix in 6-and 8-yd. trucks. This concerete is premixed at their yard and has proven very satisfactory. The company has assigned a radio dispatcher at the job site and the pours proceed with very little difficulty.

DESCRIPTION OF NO-JOINT MACHINE

The No-Joint pipe machine consists of a steel sled or slip from which closely fits the sides and semicircular bottom of the excavated trench. A gasoline engine is mounted on the bottom and forward end of the form. This engine operates a manually controlled, varied speed cable drum which moves the sled forward by attaching a steel cable to a deadman. The engine also operates a generator-electric motor assembly. The electric power actuates a vibrator that is attached to the bottom of the inside form. Frequency of the vibrator may be changed.

The inside form, outside top form and hopper, consisting of one assembly, are supported by and attached to the sled by hinges. The hinges permit the traveling form to adapt itself to the bottom of the inside form.

A spading mechanism, consisting of a spade shaped tool on each side of the hopper, is moved up and down by a geared mechanism actuated by an electric motor mounted on the hopper. The spading device moves the concrete down and around the form while the vibrator compacts it. Speed of the spading mechanism may also be varied.

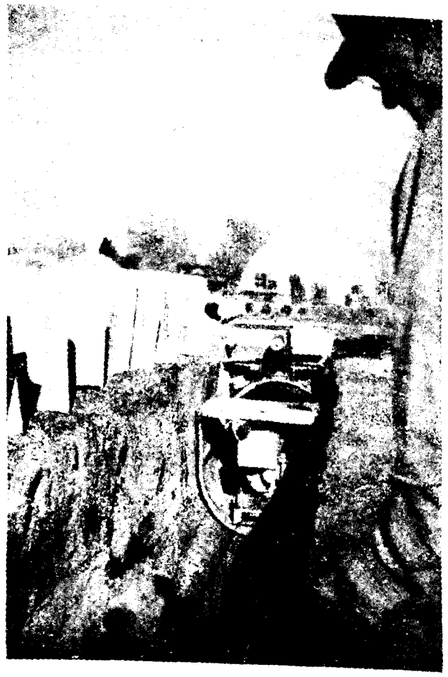
The collapsible metal semicircular forms which are fed into the front of the hopper assembly are hooked together as the traveling form moves forward. These forms contact and support the top and sides of the pipe. They are held in place by wood struts or spreader bars placed at the bottom of the forms. These forms, approximately 4 ft. in length, are 20-gauge sheet aluminum alloy and are provided with fastening hooks at the top. The arc is approximately $\frac{3}{3}$ of the circumference of a circle.

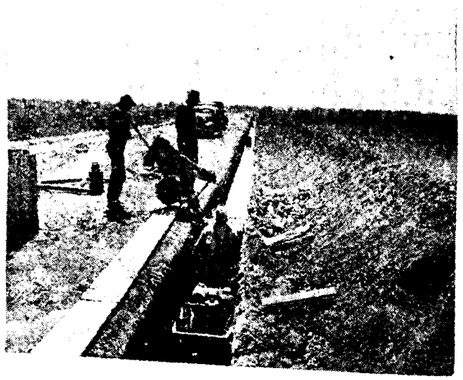
CONSTRUCTION PROCEDURE

With a year-round growing season, we are able to schedule the replacement of $\frac{1}{2}$ mi. of open irrigation lateral, including the $\frac{1}{4}$-mi. turnout structures, in about 10 days. Under this construction schedule the farmer may order water through new concrete pipe lateral within 2 weeks of his previous irrigation. The irrigation frequency is often equal to this period of time in this area.

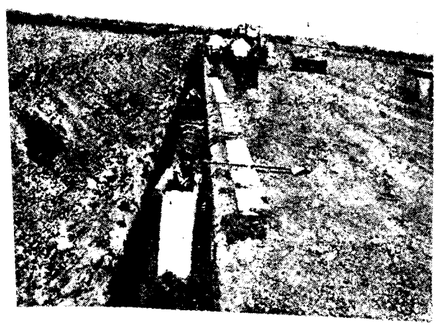
The first operation in replacing an irrigation lateral with a concrete pipe is the removal of trees and old irrigation turnout and road crossing structures. After these structures are removed, using conventional equipment, the open lateral is filled 2/3 full with a bulldozer and the remaining ditchbanks are leveled out. Usually water is delivered through the ditch before start of construction, so compaction of the fill material by a sheepsfoot roller is all that is required.

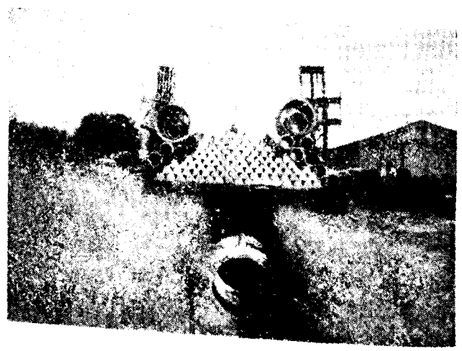
View of 30-inch Dia. No-Joint Concrete pipe suspended over washout. Pipe is suspended for a length of about 45-feet. Soil was eroded during floods of December 1955—on ranch near Westley, California. Pipe was constructed in Aug. 1952. This photo was taken in March 1956.





These Photographs were taken at various sites on different occasions during the construction of No-Joint Concrete Pipes





This completes the site clearing operation and the construction forces prepare to excavate the trench.

A trench 4 to 5 ft. deep and semi circular is excavated to grade with a Gradall. The construction forces generally excavate only enough for the following day's pour, and as a result the trench is moist enough for a concrete pour.

The traveling slip form is placed in the trench which must be completely free of water, mud and debris before pouring concrete. The form is fastened to a headwall or turnout structure with a short section of precast concrete pipe connected to the turnout. The joint is then cleaned, moistened and a layer of mortar is applied before the adjoining section is formed.

LOW-ALKALI CEMENT USED

Stiff premixed concrete is transported to the site by a ready mix concrete company. A six-sack mix of Type 2 low-alkali cement with an air entrainment agent is used, and the well-graded coarse aggregate has a 3/4-in. maximum size. The sand used in the mix passes through a 3/16-in. or 1/4 in. square opening. Water-cement ratio is controlled to provide a maximum of 3 in. before consolidation.

As concrete is placed in the hopper from the truck the cable drum winds up the cable attached to a deadman pulling the traveling form forward. Spades in the traveling slipform move the concrete down and around the circumference of the pipe and the vibrator on the inside form compacts it. As the machine moves forward on this sled the collapsible semicircular forms are inserted into the machine by a man who hooks them together. At the same time another workman inside the traveling form inserts the horizontal support struts to hold the forms in position. He also smooths the concrete in the invert of the pipe, if necessary.

For the 30 in. pipe the pour is at the rate of 250 ft. per hr., finishing the day's pour of 500 to 560 ft. in 2 to 2½ hr.

A man working at the rear of the traveling form wood-floats the upper outside surface of the newly formed pipe, when required, and regulates the speed of the spading mechanism. A 6 in. minimum cover of damp earth backfill is placed over the concrete, about 8 to 12 ft. in back of the machine.

(Continued on page 140)

According to the temperature, 2 to 4 hr. after the pour, the struts are moved and the collapsible metal forms are unhooked, turned and rehooked. These forms are then pulled out by cable to the position in the trench where they will be used for assembling the next day's pour. The forms are unhooked, lifted out of the trench, sprayed with light fuel oil, and placed along the bank.

Backfilling the trench to a minimum of 2½ ft. is completed the next day or two. The soil cover is kept damp while curing the concrete.

COST INFORMATION

Prior to the installation of No-Joint the conventional concrete slipform was the most economical method of rehabilitating the old earth waterways. The monolithic pipeline is as economical as the slipform with all the added advantages of a closed system.

Since no two jobs are the same due to right-of-way problems, tree removal, over excavation in rocky areas and hauling of backfill, the costs vary. The following is the summary of average costs per running foot on seven 30 in. and two 42 in. concrete pipe installations :

	Pipe Size 30-in.	42-in.
Labor ..	$0.62	$0.76
Material ..	1.45	2.38
Transportation and heavy equip.	0.42	0.62
Miscellaneous ..	0.62	0.82
Overhead ..	0.22	0.26
Total ..	3.33	4.84

Another comparison of costs with precast is taken from actual bids for pipe installation on April 29, 1957. We prepared all right-of-way, made the initial leveling out with the dozer, and performed all the field and office engineering.

	Bid price Precast pipe	per foot No-Joint pipe
30 in.—8,800 ft. ..	$ 6.73	$ 4.09
42 in.—3,000 ft. ..	10.76	6.20
48 in.—4,850 ft. ..	12.80	8.09

New Types of Welders Developed by a British Firm

SCIAKY RAMC 10 BENCH SEAM WELDER

SCIAKY Electric Welding has again made its contribution to increased production in the scientific instrument field by developing the Sciaky RAMC 10 Bench Seam Welder.

This machine produces a pressure tight joint on preformed stainless steel diaphragms and capsules used in the manufacture of scientific instruments and electrical control gear, supplied to the Atomic, Aircraft, Marine and Chemical industries. Suppliers to these industries know the exacting tests to which components of this nature are subjected and this is proof in itself of the high quality welding produced by this machinc.

Its flexibility is demonstrated by the fact that it can weld added thicknesses of mild and stainless steel from .010″ + .010″ to .036″ + .036″ and can be adjusted to suit diaphragm diameters from 1¼″ to 6″. By using an infinitely variable hydraulic drive incorporating finger tip adjustment, welding speeds from ½″ to 4ft. per minute can be obtained. In this case, the bottom horizontal electrode jig assembly only, is driven. The top electrode, being at right angles to the bottom is an idler wheel.

The whole sequence of operations is electronically controlled by a Sciaky type DEK R/S fully synchronous control incorporating phase-shift heat control, half cycle timing and Ignitron contactors. A separate cubicle houses these controls and they consist of removable trays and plug in units for easy service or inspection.

SEQUENCE

Having located the two halves of the diaphragm on the bottom electrode jig, a clamp is applied. The operator then initiates the weld sequence, the top electrode applies the welding pressure, while the drive rotates the complete unit for welding. The whole sequence is controlled by an overall process timer, on completion, the welding head retracts, allowing the finished component to be removed. On 1½″ units a time cycle of 8 seconds is attained.

During the welding period flood water cooling is used to prevent distortion, a control being fitted to allow water to flow for this period only. This machine although generally accepted by instrument manufacturers for this particular application can, however, be tooled to embrace a wide variety of components.

(Continued from page 139)

FUTURE PLANS

The firm of Concrete Ditch Lining Service, owned and operated by Philip R. Congrove, has obtained a franchise with the No-Joint company to operate in Arizona and we hope that for the following year, at least 18 mi. of this pipe will be installed. We will have to accomplish this without interrupting the irrigation demands throughout the year.

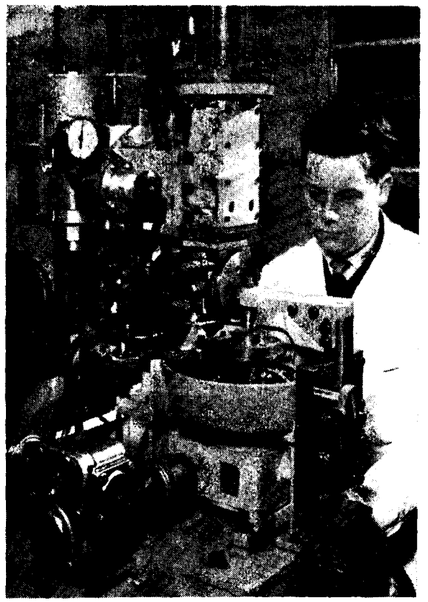
TWO-YEAR RECORD AND PERSONNEL

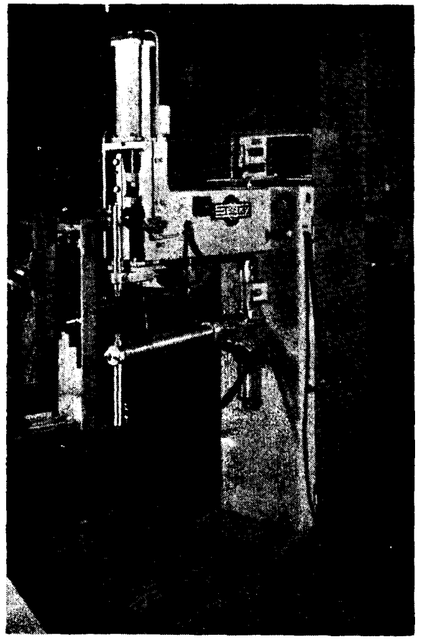
Since October 1955 we have installed a total of 113,465 ft. The pipe has given very satisfactory service. We also recognize that the soil conditions are favourable for this type pipe, the lower operating heads are ideal and the absence of extreme low temperatures all contribute to the success of this low cost concrete pipe. Of course, we get the characteristic expansion and contraction cracks of concrete pipe. They have all been circumferential, extremely few, far less than the 4-ft. lengths of precast pipe.

I would like to mention a few of the men who are responsible for this program both in office and field.

Engineers have been Jake Miller, Reid Teeples, Don Womack, Bert Griffin and Tom Sabin designing the structures ; field construction has been directed by Bud Simser, superintendent of construction and maintenance ; Floyd Wright, supervisor ; Cecil Williams and Stone Chapman, construction foremen : Bill Blanton, pipe machine foreman ; Ken Skinner and his survey crews, and finally, the inspection has been carried out by Charlie Dacon, Lee Coons and Frank Oglesby.

R. J. McMullin is general manager of the Salt River Project. For additional information write to: No-Joint Concrete Pipe Co., P. O. Box 609. Yuba City, California. (Courtesy : " WESTERN CONSTRUCTION ")





SCIAKY RAMC 10 Bench Seam Welder & Rapid " High-Lift" Spot and Stitch Welder

SCIAKY RAPID ' HIGH-LIFT ' SPOT & STITCH WELDER

A recent addition to the Sciaky range of resistance welding machines is the Sciaky ' High-Lift ' Rapid Spot Welder.

Developed to give greater access for deep drawn pressings or work of a similar nature. The high lift is used to retract the top electrode whilst the component is offered to the welding position. It is then lowered into the normal working position this reduces the welding stroke to a minimum. The same high rate of production and conservation air is achieved.

The Sciaky Rapid is a fully automatic general Spot and Stitch Welder designed for operation by unskilled labour. Capable of stitch welding speeds up to 250 fully controlled spots per minute, the Rapid Spot Welder will weld MS sheet up to .250″ + .250″ and MS wire up to .625″ + .625″.

Available with an 18″, 24″ or 30″ throat depth, the arm arrangement is reversable allowing electrodes to be mounted vertically or angled, while the arm height is easily adjustable on a vertical pillar.

A fully interlocked control circuit is operated by a Sciaky 4 channel electronic Thyratron unit, providing varying timing for the " Squeeze ", period before initiation of the welding current, actual " Weld " time, " Hold " period when the electrodes remain closed to give extra forging action, and " Off " time which governs the repeat Spot and Stitch welding speed.

The electronic control is visible and adjustable from the working position ; indicator lights showing when the panel is switched on and the valves ready. The timer is easily detachable from its cabinet by a plug and socket.

Amsler Morton Company
First in Design of Industrial Furnaces

AMSLER Morton Company was founded in 1903 as a company dedicated to the principals of progressive engineering.

From the very beginning, the company's efforts were aimed at developing inproved heat transfer and associated equipment. During the early stages of growth, the company's activities were channeled toward the glass industry with the result that complete glass plants were designed and built by Amsler Morton. Among the many AMCO contributions to the glass industry are the first successful muffle type, raw producer gas-fired continuous annealing furnace, or lehr, and the AMCO high temperature refractory recuperator. The AMCO recuperator was adapted to the melting furnace with the result that several hundred glass melting furnaces were designed and built by Amsler Morton during the 1920's.

With the experience obtained in the glass industry, AMCO turned its engineering talents to the steel industry. A careful survey of the steel industry's needs disclosed a quality and production bottleneck in that important step between the melting of steel and its primary rolling into bloom or slabs; namely, the soaking pit. The old soaking pit shops could not meet the demands of modern mills and, when "forced", the stock was often burned and pit maintenance costs, as well as finishing costs and rejections, climbed prohibitively.

In developing a solution for this problem, the company first adapted its recuperator to ingot heating service. Another important step was the creation of a furnace design that would replace the more or less standard type soaking pits row for row and more important, increase the setting capacity and production per row. The usefulness of the AMCO design was then further enhanced by adapting it for all gaseous and liquid fuels by equipping it with specially designed mechanical equipment and by the further addition of fully automatic combustion and temperature controls.

The recuperative ingot heating furnace that was finally evolved was in keeping with the AMCO tradition of creating a fool-proof design to solve a given problem. It has proven unusually acceptable and to date more then six hundred AMCO recuperative soaking pits have been installed throughout the world.

In addition to serving the steel industry with a superior soaking pit design, Amsler Morton has extensive experience in the design and fabrication of many of the furnace types commonly used by the steel industry.

Included in this group, are open hearth furnaces, continuous strip annealing furnaces, bell type annealing furnaces, walking beam furnaces, forge furnaces, tube normalizing furnaces, gas alloying furnaces, galvanizing furnaces, continuous slab heating furnaces, rotary hearth furnaces, roller hearth furnaces, car type furnaces and a variety of controlled atmosphere furnaces.

Typical of the progressive designs, in the light furnace field, which have originated with Amsler Morton, is a series of pit type gas carburizing furnaces presently being constructed for a major North American steel producer. Then, furnaces are designed in recognition of the present trend toward high temperature carburization for operation at 2000° F. Each furnace is designed for a 6000 pound charge and circulation of the carburizing gases by a radial fan rated at 2000 c.f.m. Modification of this furnace design has been made by AMCO for adaptation to more exotic gas alloying processes.

In the past few years, AMCO has applied its knowledge of heat transfer equipment to the non-ferrous metals with particular emphasis to the treating of aluminum. The effort expended has resulted in superior furnace designs for homegenizing, reheating, annealing, aging and melting.

Fifty-eight years have passed since Amsler Morton Company was founded. In that time, the company has become firmly established as a supplier of superior quality industrial furnaces for the glass and metal industries.

PROTEXULATE—New Mineral Powder
for use in Underground Pipe Installations

PROTEXULATE Limited are pleased to announce that owing to the extensive development of their business in the U. K. they are now able to extend their activities to cover all overseas markets.

Their unique material called Protexulate is a fine mineral powder, prepared by a patented process, for use in underground pipe installations. This revolutionary product provides buried heating pipes with highly efficient thermal insulation and complete protection from corrosion—two benefits combined in one material. In addition, *the overall cost shows great economical advantage over other methods of installation.*

Protexulate's Remarkable Properties:

WATER-REPELLENCY. Protexulate is permanently waterproof. Infiltration of moisture, even when the ground is saturated with water, cannot occur, owing to Protexulate's extraordinary surface tension. Its free-flowing condition is maintained indefinitely and, although impermeable to moisture, it allows the pipeline to " breathe ".

THERMAL INSULATION. The Thermodynamic Laboratory of the Liege University carried out tests whieh determined the thermal conductivity of Protexulate to be as low as k = 0.912, dependent upon the temperature.

A Typical PROTEXULATE Installation

More Production of Industrial & Medical Gases

The Industrial Gases Industry and Indian Oxygen Limited

THOUGH relatively young, the industrial gases industry is being assigned an increasingly important role in the industrialisation efforts of India. How effectively this role has been played can be traced in the growth of Indian Oxygen Limited, pioneers in the field of the products and processes of industrial and medical gases.

A HISTORY OF FIRSTS

In 1935 Indian Oxygen operating from its Head Office at Mission Row, Calcutta had only five factories two of which were outside present-day India. Since then the rapid development of the Company can be gauged by the existing forty-five factories branches and depots scattered across the length and breadth of India with some 3,500 Indian Nationals employed in the indispensable task of keeping industry's many wheels turning. As can readily be appreciated only the Company's ability to pioneer new methods and processes in this vital field has enabled it to achieve and maintain its leadership in this business in India.

The first nitrous oxide plant in India and indeed in this part of Asia was started by the Company at Calcutta in 1944 and this was followed in 1947 by the first indigenously manufactured mild steel electrode.

The first wholly manufactured piece of medical equipment was produced at Calcutta in 1952 and the progressive assembly and manufacture of a broad range of Oxy-acetylene Welding & Cutting Equipment and accessories at the Company's Equipment Factory marked yet another first in India in 1958.

1960 saw the commissioning of India's first argon producing plant at the Burnpur Works of Indian Oxygen, whilst in 1961 the first Indian made gas

(Continued from page 143)

TEMPERATURE RANGE. Protexulate can be used for conduits with temperatures up to 480°F.

DIELECTRIC PROPERTIES. The dielectric constant is 2.7

CORROSION PROTECTION. Protexulate provides complete protection from corrosion in all types of weather conditions.

SIMPLE AND RAPID IN APPLICATION :

Protexulate is simply poured direct from the bags into the trench covering the pipeline to a depth based on the dimensions of the pipes. The empty multi-ply paper bags are then placed over the powder and the trench filled in with earth.

TIME AND LABOUR SAVING :

Owing to the ease of application, very little labour is required. No curing process or protective coating is needed, nor is any concrete ducting and separate lagging required, which means an enormous saving in time and cost.

SAFE AND EASY TO STORE :

Protexulate is absolutely non-inflammable—in fact it can be used as a fire extinguisher. It is absolutely safe to handle under all conditions. Its specific gravity, depending upon the degree of compression, is about 60-lb./ft³. Protexulate can be stored indefinitely, even under the most unfavourable conditions, without any fear of deterioration. Moreover, the same powder can be used again should resiting of installations be necessary.

Protexulate (British and Foreign Patents) can be used in :—

District heating systems,
Industrial construction,
Oil Refineries,
Hospitals,
Chemical and petrochemical industries,
Schools,
Municipal Buildings, etc.

For further information, installation data, and technical literature contact the Sole Suppliers :— PROTEXULATE LTD., 27 St. James Road, Kingston-on-Thames, Surrey, England.

cutting machine came off the assembly line of the Company's Equipment Factory.

INDIAN OXYGEN'S PRODUCTS AND SERVICES

The activities of the Company may be categorised under five broad heads :—

(1) The manufacture &/or sale of industrial and medical gases (oxygen, acetylene, argon, nitrogen, nitrous oxide, hydrogen, compressed air etc.

(2) The manufacture and sale of gas welding, cutting and medical equipment, and gas welding accessories at the Equipment Factory.

(3) The manufacture and sale of arc welding electrodes and fluxes at the electrode factory.

(4) The distribution of automatic, semi-automatic, gas shielded and manual arc welding equipment and accessories.

(5) The manufacture and sale of Loxite, the patented name of the liquid oxygen explosive invented by Indian Oxygen.

To ensure that the Company's customers received the best possible advantage from the equipment and processes made available to them, for many years Indian Oxygen has trained its own Sales force and there are now some 48 Sales Representatives all of whom have spent nine months or longer undergoing comprehensive training at the Company's Sales Technical Service Section, Calcutta in the use of its products and processes. These Sales Representatives who are equipped with vans are able to visit customer's premises at short notice practically anywhere in India to give advice or assistance free of charge to anyone needing it. Specialists are also available at Company's main branches to install and give training in the operation and maintenance of Quasi-Arc, Fusarc, and Unionmelt Automatic Arc Welding Equipment which are being increasingly used in India in heavy industry. Moreover, the Company has a growing number of Medical Representatives who keep in touch with the needs of hospitals and medical practitioners throughout the country. In addition, the Company operates an after sales service commonly known as the ' Medical Service Scheme ' which is unique in India. This scheme ensures that all medical equipment covered by it is regularly checked and serviced by skilled engineers who are able to detect and remedy all but major defects on the customer's premises thus ensuring that vital apparatus is maintained in uninterrupted working condition ready for emergency use at any time. The rapidly increasing number of medical apparatus being sold in India clearly indicates the confidence which is felt in our medical equipment by Doctors, Surgeons and Dentists everywhere.

Liquid Oxygen explosives have become so important in the years since their introduction in India that the distribution of liquid oxygen and supply of cartridges is rapidly becoming one of the Company's major enterprises. This process has many advantages over the use of high explosives with its simplification of storage, handling facilities and flexibility of use. Coalfields situated wherever it is possible for us to supply liquid oxygen are quickly appreciating the advantages of ' Loxite ' the patented name of the L. O. X. explosive introduced by Indian Oxygen Limited.

INDUSTRIAL GASES

The oxy-acetylene flame, the hottest known to man, cuts and joins steel and other metals with hitherto unimaginable ease and speed. With the use of argon an inert gas present in the atmosphere in very small proportion the welding of aluminium, stainless steel, and other metals liable to oxidation by other methods can be easily undertaken. Whilst Nitrogen is used not only in removing impurities from molten metals by the ' de-gassing ' process, and also for bright annealing of steel in the food and medical industry, its property of chemical inertness is being increasingly appreciated in the packing of foods and medicines. Hydrogen is used in the lamp making industry in considerable volumes and also in balloons used to enable the Metereological Departments to forecast weather conditions. Acetylene's main use of course, is in oxy-acetylene welding and cutting, but it is also used to a large extent as a powerful and reliable source of light in lighthouses, light ships, and buoys. The applications of industrial gases in a fast developing country are in fact far wider than can easily be imagined and the technical knowledge and experience which Indian Oxygen has gained through its continuous service to industry since 1935 is constantly being used to keep pace with the growing needs of the country.

MEDICAL GASES

A more human aspect of the Company is the service it renders to the medical profession. Medical oxygen, oxygen and carbon dioxide mixtures required in pediatrics and psychotherapy are produced at a number of its works and nitrous oxide widely used as an anaesthetic is today increasingly exported to Burma, Ceylon, Hongkong, Pakistan and Singapore.

The use of Nitrous oxide is in fact so extensive that the Company is duplicating its manufacturing capacity by the erection of a second nitrous oxide plant at Bombay to cope with the demand.

EQUIPMENT MANUFACTURE

The only one of its kind in India, Indian Oxygen's Equipment Factory at Calcutta manufactures a wide range of gas welding and cutting blowpipes, regulators, and other accessories. The extension of its activities to cover an increasing range of medical equipment is also on the way and the well known 'Boyle F' is now 80% manufactured in this country. In addition, a variety of anaesthetic and oxygen therapy equipment is also being progressively manufactured.

ELECTRODE MANUFACTURE

In 1947 Indian Oxygen pioneered the production of electrodes and its Electrode Factory at Khardah, Calcutta is producing a variety of general purpose mild steel electrodes and a number of special purpose electrodes used in bronze-welding, hardfacing and the welding of high quality steel. Fluxes used for gas welding covering the majority of industrial applications are also manufactured at the Electrode Factory and distributed throughout India.

DISTRIBUTION

The blue Indian Oxygen transport vehicle is a familiar sight on the highways around most of the major industrial areas of India. Apart from the speedy transport of gases, equipment and consumables by a large fleet of trucks and vans Indian Oxygen has also introduced piped supply of gases to customers' own premises, the only system of its kind available to Indian Industries. This process rapidly being extended to the Company's major customers wherever possible streamlines the supply and distribution problems, reduces waste and increases efficiency by its ability to provide oxygen, acetylene, compressed air, Nitrogen, or, hydrogen at controlled pressures to specific points in the customer's works. The supply of liquid oxygen in bulk also enables a very large voume of oxygen to be delivered and stored in a comparatively small space.

SALES TECHNICAL SERVICE

The Sales Technical Service Section of Indian Oxygen makes available to customers a wealth of technical information about its products, arranges demonstrations and deals with customer's problems relating to the handling of the Company's products. Another vital function of the Sales Technical Service Department is the carrying out of research and product development work. In addition the Sales Technical Service Section operates welding schools at Bombay, Calcutta and Madras where comprehensive courses both theoretical and practical in welding, cutting and allied processes are organised for beginners as well as for the experienced.

THE COMMONWEALTH OF OXYGEN

Indian Oxygen attaches great importance to its being a member of the British Oxygen group of companies with headquarters in London and links throughout the Commonwealth. Thus it is able to draw freely from a common pool of technical skills and experience and to use them in the building up of a strong, prosperous India.

THE FUTURE

The trends of our industrialisation will present many challenges to Indian Oxygen and one can assume with confidence that this vigorous organization started by the British but now run almost entirely by Indians will respond to these challenges as adequately as it has traditionally done.

THE STORY OF U. S. STEEL

By A Special Correspondent

It is often said that the dividing line between genius and insanity is very thin. Often men of remarkable talents and foresight have been taken for cranks in their time.

William Kelly of Kentucky, who proposed that steel could be made by blowing air through molten iron, was propagating ideas strange for time—the 1840's. His family and his friends considered him a demented fellow.

Fortunately for the future of the U. S. steel industry, the doctor brought in to treat him had a broad knowledge of general science—and concluded that both Kelly's research and mind were sound.

At the same time, a similar process was being evolved by an English metallurgist, Henry Bessemer.

But long before the Bessemer process was adopted for large-scale manufacturing, steel used to be made in colonial America.

At the Saugus Ironworks, in the town of the same name, ten miles from Boston, Massachusetts, excavations have led to the discovery of the first iron works. These have been restored to conditions which prevailed three centuries ago and visitors from India and all over the world have gained an insight into the lives and times of the people who helped found a nation.

It was in 1646, twenty years after the settlement of Boston and Salem, that colonists built the Saugus ironworks, one of the industrial wonders of the day. It employed the most advanced methods of iron-making then known. Its rolling and slitting mill was one of a few existing in the world at that time. It was a cooking pot that was first produced in the works and this pot is a museum piece today.

From the metal smelted in the blast furnace, pots and firebacks were produced. Crude iron bars called sows or pigs were also produced. Many of these were reheated and beaten into wrought iron. Some went to the rolling and slitting mill where they were worked into flats and rods. From the rods, the farmers made their own nails.

From Saugus to Pittsburgh was a long distance—and pioneer steel producers evolved several new procedures, eventually to place America in the forefront of steel manufacturers.

The American steel industry today consists of some 275 companies, operating in 29 states; in 1960 they produced some 99 million tons of steel consuming 118 million tons of iron ore. America's installed capacity is 145 million tons.

From the Cambria Ironworks (now a Bethlehem Steel Company plant) where crucible steel was first commercially produced, came a long line of successful steel makers and engineers. Abundant resources of high-grade iron ore and accessible coal fields gave them raw materials with which to work.

The rapid development of the West was a stimulation to the industry. Many an immigrant, handicapped without iron for tools, tried to make this metal in order to continue his farming. Later in the 19th contury, when more types of agricultural equipment had been invaded, those required large quantities of steel.

The development of industrial machinery in the United States during the 19th century went forward side-by-side with the growth of the iron and steel industry. New machinery led to research for ways to produce more and better iron. Increased quantities of iron, then steel, suggested new uses of the metal for machinery.

Iron and steel hastened the coast-to-coast development of the U. S. railroad system. As trade and travel became greater, the timber and stone bridges could no longer sustain the loads. It was in building new bridges that structural iron parts first came into wide use.

In 1862, three years after the first oil rush began in Western Pennsylvania, steel pipelines began to grow,

as oil production mounted. Today, steel products accompany oil from the time it leaves the earth until its final consumption.

Americans of 1800 were steel makers by courtesy rather than accomplishment. By 1810, America was able to produce only 917 tons of steel, and that of not too-good quality. But American steel-makers were experimenting—searching for a clay that would help them produce steel as good as that in England.

Early attempts to make crucible steel in America had come to grief because American clay pits could not seem to match the English clay quality. The problem was finally solved by Dr. William Garrard who began his professional life as a bricklayer. His venture lasted only one year, but during that time he turned out excellent steel.

While the quality of iron continued to improve, there were no important developments in steel until about 1846. William Kelly, with his brother John, began experimenting with a new type of iron ore at an ironworks they owned in Eddyville, Kentucky. He conceived the idea of blowing cold air into molton iron to turn into steel. Later, Samuel Thomas made improvements in blast furnace construction.

Since many inventors both in America and in Europe hold patents on the various phases of the crucible steel making process, the interests were combined in 1866, and came to be known as the Bessemer process.

Through the Bessemer process, about 300,000,000 tons of steel products were made in the United States between 1867 and 1944. When these products were out or became obsolete, there was a need for a steel-making process which could utilize this scrap iron and steel. The open hearth process, conceived by Siemens in his regenerative furnace, took over, and is today the most important steelmaking process in the United States. The capacity of U. S. open hearth production plants is over 85 million tons a year.

Further technological improvemedts in production are sought by new methods evolved in the United States and others adapted from Europe. What may be the industry's brightest hope for the future is the basic oxygen process, developed in Europe and widely adapted since 1954 in the United States.

The new technique is quite simple. Molten pig iron —and slag forming materials are fed into a cylindrical furnace and jet of high purity oxygen is shot into the surface of the molten mass through a water-cooled tube. The oxygen furnace produces high quality steel in a little over half an hour, faster than the open hearth furnace, which takes from six to twelve hours to make a batch of steel.

The cost of constructing an oxygen furnace is much less than the open hearth. Oxygen furnace capacity in the United States at the beginning of 1958 was 988,000 metric tons; in two years it was four times as great.

Another method for making steel, in small quantities, is now being tried out in Arizona. The process requires neither coke nor scrap iron and makes possible production of steel in small, low cost plants. A pressure retort is filled with crushed iron pellets and sealed. Hot reducing gas is injected into the retort, penetrating the entire mass of ore. Commercial possibilities of this process are now being investigated.

Still another process in the experimental stage is the producing of steel strip directly from finely powdered, highly purified iron ore simply by pressing, heating and rolling the ore without benefit of blast or open-hearth surface, coke oven or blooming mill. Strip has been produced in this manner in the laboratory, and researchers hope to perfect the revolutionary process for commercial use within five years.

The steel industry's quest for perfection is stimulated by the manifold demands made on it by other growing and new industries. The automobile industry for example requires one hundred and sixty different kinds of steel. Scientists in the laboratory are now using sound waves to make steel cleaner, stronger and more malleable. The most highly refined steel has some impurity; steelmakers have tried for years to remove the unwanted elements. 'Sonic stirring' of the liquid metal makes some of the impurities rise to the surface in the ingots from which they are easily removed.

Steel with silicene is widely used in electronic transformers. Copper helps steel resist atmospheric corrosion and makes it suitable for use in the manufacturing of freight cars. The addition of chromium and nickel makes stainless steel.

Manganese toughens steel. American steelmakers have developed thousands of formulas to adapt their product of its 200,000 uses, and they keep adding to the list. For example, last year a steel company hopefully introduced coloured stainless steel on the market. It comes in eleven colours, applied by means of liquid plastic solutions.

With the reduction of high quality domestic deposits, the steel industry is turning increasingly to ore imported from Canada and other countries. Even so, sixty percent of the steel made in the U. S. is from indigenous ore. Since the beginning of the century, the industry has worked to find economical techniques for using ores which contain a lower percentage of iron of which there is no dearth at home.

The technology required to develop the immense taconite deposits of Minnesota was developed by the joint effort of several steel companies. Among all the rocks found on earth few are harder than taconite, but imbedded in it are iron deposits which had solidified in the ice age. To get at the 20 to 30 percent of iron thinly dispersed in taconite, men first had to learn to mine it. The jet piercing rig developed for taconite sinks blast holes in stubborn rock by means of a 4,300 degree flame of oxygen and fuel oil while sprays of water flush out particles of burned rock. Super tough alloy steels had to be made to forge the instruments for this mining operation.

Pittsburgh in the mineral heartland of Pennsylvania, was the nation's first steel city. A number of other towns rose to prominence as steel cities: Gary, Indiana; Cleveland, Ohio; Birmingham in Alabama, named after the British steel metropolis. Pittsburgh still produces a large part of the nation's steel, but pursuing the spreading market plants have been buit in 29 states. There are large steel mills in California and Texas, Utah, Kentucky and Maryland.

At different periods in the growth of the American economy, cotton and coal have occupied pre-eminent positions. 'King cotton' and 'King coal' have lost their royalty with the advent of man-made fibres and petroleum. Though steel, rugged and lasting, never was installed on a pedestal, it continued to supply the backbone to American industrial expansion.

The Development Programme for the Non-Ferrous Metals Industry

After three years of intensive study of conditions for the erection of new refinery plants and the reconstruction of existing ones at the Trepca lead and zinc mines and smelters, the development programmes are now being finalized. The basic object of the expansion programmes is to ensure the better utilization of raw materials and the attainment of a higher degree of finishing.

One of the most important projects will be the construction of a zinc electrolytic department of 18,000 ton capacity. Until now zinc concentrate alone was produced at Trepca.

The reconstruction of the lead smelter, whose capacity, upon the completion of the works, will amount to about 120,000 tons of crude lead, will also be an important undertaking.

Plans for the erection of a small iron ore reduction plant with capacity of about 75,000 tons of pig iron are also being prepared. The raw material for the iron would be the roast-sintered iron pyrite ores which remain after the production of superphosphates in the new factory which is now being completed at Kosovska Mitrovica. Conditions for the erection of a lead and zinc rolling mill for the finishing of these metals into tin, folios, strips, tubing and other products are being examined.

Separate departments for the production of sulphuric acid would be erected adjacent to some of these new projects, while the possibility of constructing a separate factory for sulphuric acid production which would be obtained from pyrite concentrates is likewise being examined.

A capital investment loan has been allocated to the Trepca enterprise for the construction of a new storage battery factory of a capacity of 6,000 tons annually. It is estimated that about 60 percent of this output would be sold on the domestic market, while the remainder would be marketed abroad.

(Commercial News of Yugoslavia)

RAILWAYS AND THE THIRD PLAN

THE Third Plan of the Railways has been formulated on the basis of an expected originating traffic of 245 million tons in 1965—66. This is 91 million tons more than what Railways handled at the end of the Second Plan.

In respect of passenger traffic the railway programme provides for an increase of three per cent per year in the non-suburban traffic. The increase in the suburban traffic is likely to be of a substantially higher order.

Of the total increase of 91 million tons of freight estimated during the Third Plan, 79.5 million tons are accounted for coal, steel and raw materials for steel plants, cement, iron ore for export etc. The remaining 11.5 million tons represent expected increase in general goods traffic.

The rapid development of the country' economy over the past decade has placed heavy demands on transportation system. The Railways, on whom the main burden falls, are handling today 100 per cent more freight traffic and 27 per cent more passenger traffic than they were handling before the commencement of the First Five Year Plan.

The main task during the First Plan was the rehabilitation of railway rolling stock and track renewal which had been subjected to great strain during the preceding years. In the Second Plan, in addition to making up the arrears of replacement, emphasis was laid on augmenting line capacity and procurement of additional rolling stock to meet the increasing demand for railway transport arising from the increased production in the agricultural and industrial sectors.

During the two Plans, the number of wagons, in terms of four-wheelers, has increased from 222,441 to 341,041, that of coaches (units from 20,502 to 28,171 and locomotives from 8461 to 10554. About 13,00 miles have been doubled and 800 miles electrified, 1200 miles of new lines added to the system and 400 miles dismantled during the war have been restored.

SPURT IN RAIL TRAFFIC

The originating traffic on the Railways has shot up from 91.5 million tons in 1950—51 to 154 million tons in 1960—61. The average load of freight traffic has gone up from 292 miles to 354 miles, during the period. In terms of tons originating, the volume of traffic has increased 69% and in terms of ton miles it has gone up by over 100 per cent. It has been recognised that the demand for transport has risen at a substantially faster rate than the increase in national income or the growth of production in any major sector of the economy during the period.

Difficulties have been experienced in the movement of coal particularly from the Bengal-Bihar coalfields. This is partly due to changes in the pattern of coal production and in the plans for supply of raw materials to the steel plants, resulting in longer leads for the Railways than were originally anticipated. To some extent it was also due to a short fall in some of the Railway development programmes, notably wagon procurment.

There has been relatively a much larger increase in suburban traffic than in the inter-city traffic carried by the Railways. The volume of suburban traffic increased from 4247 million passenger miles in 1951—52 to 7500 million passenger miles in 1960—61, that is, by 77 per cent as againt a 24 per cent increase in the over-all passenger milles during the period.

The Planning Commission envisages a review of the programmes for transport when the final report of the Committee on Transport Policy and Coordination is available. It is, however, recognised that during the Third Plan, the Railways will inevitably have to continue to carry the bulk of traffic in heavy goods—coal, iron ore and other materials for the steel plants etc. While there is a general shortage of transport in the country today, which is likely to continue for some time, this will not necessarily preclude competition between rail and road transport over certain routes and in respect of certain commodities. Consideration of Co-ordination will have a still greater

importance in regard to proposals for the construction of new rail lines. As in the first two Plans, most of the new lines to be opened in the Third Plan are needed to meet the operational needs of the Railways or for the movement of basic commodities.

RAILWAY DEVELOPMENT PROGRAMME

The cost of the Railway development programme as at present formulated is estimated to be of the order of Rs. 1325 crores. The break up is as follows :

Programme	(Rs. crores) estimated cost
rolling stock	510
workshops, machinery and plant	62
track renewal	170
new lines	147
electrification	70
signalling and safety works	25
traffic facilities (line capacity works)	183
bridge works	25
other electrical works	8
other structural works	15
staff quarters and staff welfare	50
user's amenities	15
road services	10
stores suspense	35
Total	1325

REQUIREMENTS FOR ROLLING STOCK

The programme for rolling stock provides, besides replacement of the over-aged stock, for acquisition of 90,447 wagons (four-wheelers), 5025 coaching vehicles and 1150 locomotives. The programme also includes establishment of production of electric locomotives at Chittaranjan in collaboration with the Heavy Electricals, Bhopal and diesel locos in the public sector.

LINE CAPACITY WORKS

The Third Five Year Plan for the Railways provides for doubling of 1600 miles of single track, remodelling of certain yards, opening of crossing stations and provision of crossing loops. The Railways have to concentrate on strengthening the trunk routes and the lines on which the traffic in heavy commodities required to be moved in increased quantities in future.

The programme for electrification in the Third Plan provides mainly for completion of works on those sections which already are on hand. The only new section which for the present is proposed to be taken up is that from Mughalsarai to Kanpur.

OTHER ENGINEERING WORKS

The Third Plan provides for undertaking track renewals of about 5000 miles, rail renewals of 2500 miles and renewals of sleepers on about 2250 miles.

The programme for bridges is confined mainly to the works carried forward from the Second Plan ; the two major bridges taken up during the Plan are the Brahmaputra bridge and that over the Jamuna at Delhi.

It is proposed to improve signalling and telecommunication facilities including the inter-locking of some sections during the Third Plan. Centralised traffic control will be provided on the link route leading to Assam.

NEW LINES

About 1200 miles of new lines will be constructed during the Third Plan period. Besides the new lines carried from the Second Plan, 12 new lines including those from Madhopur to Kathua (in Kashmir) and to Haldia Port will be laid during the Third Plan.

It is also planned to construct 200 miles of new lines in connection with development of coal industry. The following lines are under consideration for inclusion in the Third Plan : (1) Mangalore—Hassen, (2) Bangalore—Salem, (3) Manamadhurai—Virudhunagar and (4) Rail link from Sukinda/Daitari mining areas in Orissa to the main line from Kharagpur to Cuttack.

STAFF WELFARE

Of the total of Rs. 50 crores proposed for staff welfare Rs. 35 crores are intended to be utilised for construction of staff quarters in the Third Plan. About 54,000 new quarters are expected to be constructed in addition to those that are constructed as part of composite projects. The staff will also be provided with better medical and educational facilities, recreations in workers' colonies etc.

USERS' AMENITIES

The Plan provides for Rs. 15 crores for more and improved amenities at Stations and in trains. The programme covers remodelling of stations, provision of retiring, waiting and refreshment rooms and electrification and improved drinking water facilities at station. All schemes have to be drawn up on austerity standards due to limited funds available for the purpose.

SELF-SUFFICIENCY DRIVE

Substantial increase in capacity for the manufacture of rolling stock has been achieved. All the steam locos, coaches and wagons needed by the Railways are manufactured in the country. Complete self-sufficiency has been obtained in respect of mechanical signalling equipment. Capacity is also being created to produce the entire supplies of track materials needed by the Railway within the country.

To the extent possible efforts will be made in the Third Plan to manufacture diesel and electric locomotives and other items of equipment in the country, which are still being imported.

In view of these endeavours, the requirements of foreign exchange for the Railway development programme in the Third Plan are estimated at Rs. 186 crores as against Rs. 332 crores estimated to have been spent during the Second Plan period.

IMPACT OF BHAKRA PROJECT ON INDIAN ECONOMY

HARNESSING OF SUTLEJ — A NEAR MIRACLE

By Gurnam Singh Tir
Punjab Government

SOME 45 years ago, one sunny day, a party of hunters noticed a tiger springing across a deep chasm from one rock to another. A few hundred feet below thundered the river Sutlej in a desperate bid to free itself from the mountain-locks of the Lower Shivaliks.

An idea flashed through one of the hunters : the river could be dammed, and its waters used for the service of the people, for irrigation and production of electricity, in a natural bowl above this point.

" Fantastic " was the comment from another hunter. " Who can thwart the flow of a river ? It is beyond the power of earthlings ". He tried to nip the idea in the bud.

IDEA TRANSLATED INTO ACTION

But the idea could not be killed. Men of vision, wisdom, engineering skill, and determination put their brains together, and, after several years' hard toil, they decided to meet the challenge, to grapple with the gushing river, and perform a near miracle for mankind.

And then, the idea was translated into concrete action. Rocks cut, roads laid, railway tracks built ; machines, vehicles, giant cranes, equipment, cement, steel, stone and dynamites started reaching the spot in trainloads and crawling carriers.

The site of the dam was converted into a round-the-clock beehive of action. Today the great dream has come true, and the place has become a centre of modern pilgrimage.

Here is our " modern temple ", the massive and mighty Bhakra Dam, with which is linked a network of other projects such as the Nangal Dam, the Nangal Hydel Channel, the Ganguwal and Kotla Power House, the Bhakra Left Bank Power House, the Bhakra Right Bank Power House, the Bhakra Canal System and the Bhakra-Nangal transmission and power-distribution system.

BHAKRA—MORE THAN A SHOW PIECE

The story of the ever-expanding power lines and water channels in Punjab is part of the stirring saga of self-reliant and hardworking Punjabis, producing

(Continued from page 148)

more and more foodgrains, cash crops and factory goods, and providing a stable and wider base for the economic development of the country. To them the multi-purpose Bhakra-Nangal project is not only a show-window of the throbbing and progressing Punjab, as it is for India, but it also guarantees their future prosperity.

For Punjab, a predominantly agricultural State, lasting economic prosperity depends on two things — ration reduction of pressure on land and maximum growth of industry. Both these things involve modernisation. Water for the fields and power for the factories. And these two requirements are fulfilled by the Bhakra-Nangal Project.

A network of nearly 2,500 miles of powerlines from Bhakra, Nangal, Ganguwal and Kotla carries light and energy to brighten the Punjab countryside, illuminate the towns and feed the factories. Due to expansion in power production, the number of factories in Punjab has risen from 800 in 1947 to nearly 3,500 now, and the value of the products is estimated at Rs. 1,000 million every year.

The agricultural income of the people of Punjab has also spiralled to nearly Rs. 4,000 million per year.

Further, the wealth of power and water generated by this benevolent giant is shared by the adjoining State of Rajasthan and Delhi and Himachal Pradesh.

GROWING NEED FOR POWER

The rapid pace of industrialisation and mechanisation of agriculture in Punjab, backed by a rising demand for power by the neighbouring States, is fast outstripping the available production of energy. The total installed capacity of the three power houses, built under the Project, is 604,000 kWs. The installation consists of five units of 90,000 kWs each at the Bhakra Left Bank Power House, four units of 24,000 kWs—two each at Ganguwal and Kotla Power Houses—and two units of 29,000 kWs., one at Ganguwal and Kotla each.

The Bhakra units, at minimum head, will generate 53,000 kWs each, and, considering one unit as standby, the total primary power available from the Bhakra Left Bank Power House will be 212,000 kWs.

Keeping in view the shares of Rajasthan and load commitment to Delhi, Jammu and Kashmir and Himachal Pradesh, the total demand on the Punjab generating system will reach 1,396 million watts by 1970—71. For a planned future, therefore, it has been found necessary to have long-range schemes of thermal and atomic generation.

Schemes costing nearly Rs. 1,730 million are being taken in hand, and an expenditure of Rs. 530 million is anticipated to be incurred during the Third Five Year Plan period.

PLANNING FOR FUTURE

Among the major schemes to be executed in the near future for the expansion of power in Punjab are the Bhakra Right Bank Project (costing Rs. 353 million), Dehar Power House (costing Rs. 1,167 million), as part of Beas Dam Project), Pong Power House (costing Rs. 936 million), extension of Uhl River Hydro-Electric Scheme (Rs. 47 million), utilisation of canal falls in Upper Bari Doab and Western Jumna Canals, Diesel and Steam Plants and a Thermal Plant at Delhi.

The proposed steam thermal set for Delhi will generate 50 to 60 million watts. This will be installed as a joint venture with the Delhi Electric Supply Undertaking, which is installing two similar units in the power house.

This power house will be linked with the Bhakra Nangal Grid and will provide for thermal backing to the hydro-power on the system ensuring uninterrupted supply of power in scanty rain years.

In addition, ten diesel sets are proposed to be installed in the towns of Sonepat, Bahadurgarh, Rewari, Bhiwani, Hissar, Jagadhri, Sangrur, Faridket, Hoshiarpur and Chandigarh before 1963—64. Besides this, a 15,000 kW. steam plant is being set up at Faridabad.

The installation of an atomic power station in this region is also understood to be under consideration, and the benefits from the project are expected to accrue sometime in the Fourth Five Year Plan.

The per capita consumption of electricity in Punjab has risen from 15 units per annum at the end of the First Plan to 29 units in 1961

It is also estimated that by the end of the Third Plan the per capita consumption will further rise to 100 units.

Training Programmes of the Tata Iron & Steel Co., Ltd., and their Usefulness

By

S. K. Nanavati,
General Manager, Tata Iron & Steel Company Ltd.
&
K. A. Shenoy,
Superintendent of Training, Tata Iron & Steel Company Ltd.

IT was again the vision and insight of Jamshetji Nusserwanji Tata that ultimately resulted in a full fledged comprehensive technical training programme of the Tata Iron & Steel Company Limited in Jamshedpur. When the Tata Iron & Steel Co., Ltd. started in 1907, all equipment and most of the technicians needed to run these, had to be brought from abroad. Qualified Indians were not available at that time, neither were there even a handful of experienced Indians in the field because of absence of metallurgical industries in India. "Let the Indian learn to do things himself" said Jamshetji. Thus in 1921 was set up the Jamshedpur Technical Institute—just nine years after steel was first tapped with the assistance of 250 foreign technicians who were to be eventually replaced by Indians. The birth of the Jamshedpur Technical Institute was symbolic of the pioneering efforts of Tatas in their determination to provide the necessary complement of trained Indian technical personnel at a time when hardly any facilities in the country existed for the training of technicians.

ORGANISATION AND MODE OF TRAINING

The Institute is run exactly like a works department of the Steel Company, and even the works service rules are applicable to the staff. This provides excellent grounding for the trainees who, when they secure regular employment, are able to fit in easily with the works atmosphere.

The Superintendent of Training is the head of the Technical Institue and is directly responsible to the General Manager. A Technical Education Advisory Committee advises the General Manager on all important matters concerning the department.

Arising out of the present needs of the Steel Company and the employees, the existing schemes of training can be broadly classified as under :

(a) Pre-employment training of new entrants—Graduate trainees, technical Probationers, artisan trainees and mason trainees.
(b) Trade testing and employee's training
(c) Evening classes
(d) Vacation training for students of technical institutions.
(e) Refresher courses for operatives.
(f) Training for outside organisations including the Government of India and public sector industries.
(g) Practical training of instructors nominated by the technical institutions of the State.

Pre-employment training of new entrants—Graduate trainees, technical probationers, artisan trainees and mason trainees.

Graduate Training Scheme

Under this scheme, about 25 trainees under 25 years of age are recruited every year to take a two-year course of training for senior supervisory posts.

The trainees get a monthly maintenance allowance of Rs. 300/- during the first year and Rs. 350/- during the second year and are bound by guarantee to complete their training and to serve the Steel Company, if required to do so, for a minimum period of five years. During the first year they attend the Works and the Technical Institue every alternate week. Practical training in the Works is thus supported and supplemented by theoretical lectures in the Institute. At the end of the first year, training in the Works is intensified, while theoretical lectures by Works officers are held four times a week in the evenings. The general training is completed at the end of the 18th month, and the remaining six months are devoted to specialised training in the departments.

Technical Probationers

Under this scheme young graduates in science between 19 and 23 years of age are recruited for 3 years training for ultimate absorption in production departments for positions like Assistant Second Hands Assistant Blowers, Assistant Rollers, etc. The emphasis is on-the-job training with compulsory attendance in a specially designed evening course of 3 years' duration. These technical probationers are paid Rs. 7.25—0.28—8.37 p. d. during training plus usual allowances applicable to employees.

Artisan and Mason Training Schemes

Boys between 16 and 18 years of age are trained for two years to qualify as skilled artisans. The number of trainees recruited each time depends on the requirements of the Steel Company. The trades taught equip the trainees for a wide range of jobs such as fitters, welders, machinists, blacksmiths, moulders, pattern-makers, masons, etc. Trainees receive intensive training in their respective trades in a well equipped training shop and mason shop. Apart from the main trade, auxiliary trades such as carpentry, blacksmithy and welding are also taught for a period of 12 weeks. Though the emphasis is on practical training, the trainees have to attend theoretical lectures for one full day every week.

Throughout the two years, physical training is compulsory and self-reliance is encouraged. Practically, all work in the training shop, such as sweeping the floor, cleaning the machines, bringing in the raw material and delivering the goods, is done by the trainees themselves. A uniform is compulsory and this is supplied free of cost.

During the training period, each trainee receives an allowance of Rs. 2.25 per day during the first four months ; Rs. 2.50 per day from the 5th to the 14th month ; and Rs. 3.00 per day for the remaining period. On completion of the course, he receives a minimum total emolument (inclusive of bonuses) of Rs. 150 per month.

Trade Test and Employees Training

The system of trade testing was introduced in 1944. The trade test specifications are drawn by a Joint Committee of Management and Workers' Union. The programme of test is administered by the Superintendent of Training who is assisted by a full-time Trade

Testing Officer. So far about 9,000 trade tests have been conducted. The Superintendent of Training regards trade testing as one of the most important aspects of work of the Technical Institute which has helped the Steel Company to put the right man in the right job. The specifications for the different trades, many of which have a general application, have been made available on request to many other industries all over India.

With the development of specifications and tests, there was naturally a demand from the employees for facilities to equip themselves for these tests. An employees Training Centre, complete with class rooms and a speaious workshop, was established as a part of the Institute. Training is completely free and all requisites such as tools, raw materials, etc. are provided at the Centre without any charge. Some 400 employees are always on the rolls of this centre.

Evening Classes

It is one of the declared intentions of the Steel Company to provide all reasonable facilities for technical training to its employees who have the desire and initiative to improve their prospects. Side by side with the training of new entrants to the industry, the Company has evolved several schemes to enable employees to qualify themselves for promotion to supervisory posts when vacancies occur. The courses are also open to employees of the Associated Companies and to non-employees.

The scheme consists of a number of carefully drawn up evening courses. Though some of these courses started over 30 years ago, they were put on a planned basis in 1947. A special feature of the evening classes is the duplicate system. In Jamshedpur, most workers have to work in 3 shifts in weekly rotation. Obviously a man on the 2.00 P.M. to 10.00 P.M. shift cannot attend the evening classes. To overcome this difficulty, classes held in one week are repeated the next week.

The courses are entirely voluntary but in order to encourage good attendance, cash prizes are offered by the Company. The popularity of these courses can be judged from the fact that about 400 students annually take advantage of these facilities. The total number of trainees, employees and students attending the Institute's evening classes at any time is about 900.

Vacation Training for Students of Technical Institutions

For many years now, the Steel Company is providing practical training facilities to students from engineering and technical institutions from different parts of India during long vacations. The Steel Company allots a fixed number of seats to various institutions, the selection of trainees being left to the Principals of these institutions. The period of training is limited to 6 months and students work to a regular programme.

Refresher Course for Operatives

In addition, special evening classes are conducted for employees of the Steel Company in order to help them improve their theoretical proficiency in particular subjects connected with their work, such as mechanical drawing, sketching and use of precision instruments, metric system, lubrication, reheating furnaces, blueprint reading, etc.

Training for outside organisations including the Government of India and Public Sector Industries.

(i) Training Men for Hindustan Steel

The Steel Company has extended all available training facilities to Hindustan Steel Ltd. According to the present arrangement, there are under training at the Jamshedpur Technical Institute, Graduates, Graduate Trainees, Key Personnel, Operatives and skilled workers.

Besides this, the Steel Company is also giving an orientation course of training for engineers of Hindustan Steel deputed for training abroad. This course has a duration of six weeks to six months and trainees are all graduates in mechanical, electrical or chemical engineering or in metallurgy.

Government of India Trainees

Under this scheme, the Steel Company has offered facilities to train 10 Mechanical Engineering and 3 Metallurgical Engineering Graduates every year. The Company gives a stipend of Rs. 75 p. m. and the Government pays an equal amount. The trainees receive general training for the first six months and thereafter are attached to a department for specialised training. The Company also makes arrangements for their lodging and provide medical attention at concessional rates. The selection is made by a sub-Committee consisting of a representative of the industrial establishment, a representative of the Eastern Regional Committee of the All India Council for Technical Education and the Asstt. Educational Adviser (Technical), Ministry of Scientific Research and Cultural Affairs.

Training of Burmese Nationals

In response to a request from the Government of Burma, the Steel Company has trained 11 Burmese nationals in the operation and maintenance of Sheet Mills. They were given two years intensive 'on-the-job' training in the Sheet Mills, and the programme was administered by the Technical Institute.

Burmah-Shell and Indian Tube Mill Trainees

The firms which regularly send selected graduate trainees to the Jamshedpur Technical Institute are Burmah-Shell Oil Storage and Distributing Company of India Ltd, and the Indian Tube Company (1953) Ltd. These trainees undergo a two year training course on lines similar to the graduate training course, suitably modified in accordance with the special needs of the two Companies. The trainees are bound by the the same rules and regulations as graduate trainees.

Practical Training of Instructors nominated by the Technical Institutions of the State.

Under this scheme, Technical Institute trains 10 to 12 Instructor Trainees from the State of Bihar. These trainees are offered training facilities for periods varying from 6 to 12 months with a view to enable them to become good Instructors in their own trades.

SUPERVISORY TRAINING PROGRAMMES

Along with the technical training programme, the Tata Iron & Steel Company started in 1953 the training of Supervisors at the Staff Training Institute headed by the Staff Training Officer. The Staff Training Officer is directly responsible to the General Manager who is assisted by a Staff Training Committee consisting of senior officers of the Steel Company. The present training programme in the Company seeks to develop the following essential qualities in the supervisors:

1. A knowledge of Company organisation and his place in it,
2. An intelligent appreciation of Company objectives, policies and practices,
3. Information about the background to the problems which arise on the shop floor,
4. Ability to plan and direct the work in his section,
5. Ability to lead his men and knit them together into a happy working team,
6. Making the best use of the resources that are available to him,
7. Good housekeeping and ensuring the safety of the men and equipment in his charge, and
8. Consulting his people so that they get a sense of participation in the work.

An Assessment

The training in the practical application of engineering principles is almost solely the responsibility of the industry. The development of the skill of an engineer takes place only after exposure to the light of practical experience in the job. The type of leadership to be expected would depend upon both the quality of education and post-college training the young men receive. The Graduate Training Programme of the Tata Iron & Steel Co. Ltd. has fulfilled this objective to a very large extent and today more than 80 percent of the positions of Departmental Heads and Assistant Departmental Heads including the positions of General Superintendent and the General Manager are occupied by the Ex-graduate Apprentices. The Artisan Training Scheme has served the purpose of injecting young blood into the stream of skilled workers who have by and large risen from the rank and file of unskilled and semi-skilled labour. In the years to come, it is hoped that these young boys who have been thus injected at the level of skilled workers will eventually replace the existing untrained and illiterate skilled workers thus resulting in higher productivity.

The Steel Company, however, has been very alive to the question of giving adequate opportunities for training and self-improvement of persons who have the initiative and enthusiasm to move upward within the Company. The Employees Training Scheme has amply fulfilled this objective and it is very heartening to see that the employees even in advanced age groups are conscious and voluntarily take training and derive benefit. The pattern of evening classes has served not only to help the skilled workers to move into the junior supervisory positions but also help the employees of the Associated Companies in Jamshedpur to advance in their careers. The Company has pioneered a scheme—Closer Link between Industries and Technical Institution. The aim of the scheme is to acquaint the teaching staff with the actual working environment which will improve their ability to apply fundamental knowledge to actual machines or equipment and identify the fundamental principles that are applicable in a variety of seemingly different situations in industries. It is hoped that ultimately, arising out of the scheme, a nucleus may be created in the country of consultants to industries drawn from technical institutions. The training programme for outside organisations including the three Government Steel Projects is symbolic of the contribution that is being made by Tatas to the Public Sector and also in meeting to a certain extent the shortage of technical personnel in the country.

AUTOMOTIVE TRADE & INDUSTRIES SUPPLEMENT

Automotive Servicing and Reconditioning

By N. Sundaram
Chief Engineer,
T. V. Sundaram Iyengar & Sons Pvt. Ltd.

THE demand for Automobiles & Spare parts is growing year after year and now it has reached its zenith. In such a context rendering efficient and satisfactory service facilities to Car & Truck Owners has become all the more difficult for Automobile Dealers. However, Messrs. T.V.Sundaram Iyengar & Sons Private Limited, Automobile Engineers & Body Builders, Madurai, with their branches and associate companies spread all over the South are extending the best service facilities possible to owners of Automobiles.

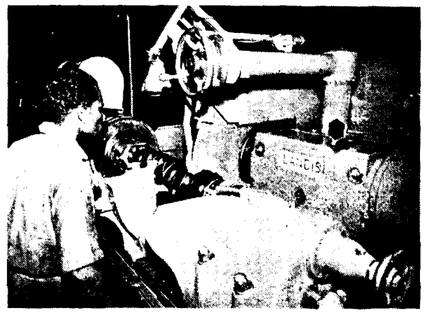
To overcome the diminishing supply of auto spares caused by the drastic cut on imports and foreign exchange restrictions, TVS undertook on a large scale the "Rebuilding & Reconditioning" of worn-out parts for Cars and Trucks.

Reconditioning & Rebuilding of worn-out parts is a highly skilled job requiring elaborate modern equipments. Situated on a six acre plot and housing over three hundred of the latest automobile machinery, TVS undertakes rebuilding and reconditioning of more than hundred items like rear axle housing, crankshafts, brake drums, propeller shaft etc., at a price very much less than the price of new parts. To mention but a few....

Motor Tester

wornout shafts, crankshafts, camshafts etc., are salvaged by Metal spraying :

"Metallizing" is the process of spraying molten metal on to a surface to form a coating—a rapid and effective method of applying any metal to any base material. Metallizing is one of the most valuable and most versatile processes for restoring wornout mechanical equipment to service for salvaging defective parts



Crankshaft Grinder

from the scrap heap, for protecting metals from corrosion and for imparting the desirable qualities of metal to non-metallic surface. Metallizing process does not very much heat up the object being sprayed and hence this process is known as cold process of building up metal.

As is common with other highly specialized processes, the successful application of metallizing is dependent upon technique—not only in the spraying of the metal themselves, but in the preparation of surfaces, in the selection of the correct metallizing wire and in the finishing of the final job. Sprayed metal is generally harder, more brittle and more porous than the original

metal and has excellent bearing characteristics due to oil retention in the pores of the metal.

Truck rear axle housing with broken ends are rebuilt to manufacturers' specifications by providing new ends at less than one third of the original cost. Excessively worn Truck brake drums are resleeved and trued up properly to obtain brake action safe and silent. The job of truing brake drums is done on High Precision Brake Drum Lathes. Spring shackles and hangers are resleeved and rebuilt to specifications. This helps Fleet Owners and other operators, to cut their maintenance cost.

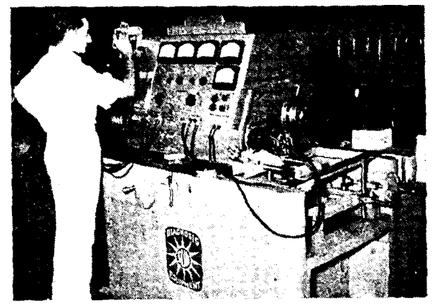
Both Petrol & Diesel Engines are rebuilt in a scientific manner to get the best performance and power from them. TVS has the latest equipments to bore cylinders to high accuracy, to align connecting rods, to line ream main bearings to high precision and to grind crankshaft journals to close tolerances. Apart from these, crankshafts are checked for flaw in magna-flux crack detector and balanced on Electronic Dynamic Balancer. Worn crankshaft journals are rebuilt by the most advanced metal spray techniques saving costly replacement. Fuel Injection pump with atomizers, the heart of a diesel engine, is thoroughly tested, overhauled and calibrated in dust-free air-conditioned booths ensuring efficient and trouble-free operation. With these and many more special equipments and genuine spare parts, engines are rebuilt within a few days by trained men to factory specifications.

TVS has latest tools and equipments for the chassis straightening and front end aligning for all makes of Passenger Cars & Trucks.

All the Service Stations of TVS Organisation are well-equipped with all modern special equipments for servicing, repairing and reconditioning of Cars and Trucks. The following are a few of the numerous special equipments used in their Service Stations :

1. Motor Tester
2. Crankshaft Balancer
3. Distributor Tester
4. Crankshaft Grinder
5. 'Metco' Metallising Equipment

Metallising Equipment



Generator & Regulator Tester

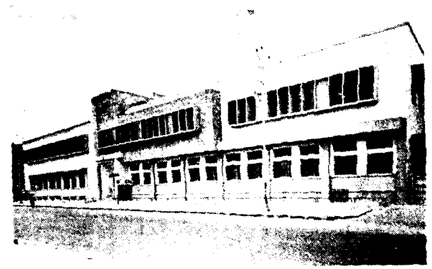
6. Brake Analyser
7. Engine Scope
8. Fuel Injection Pump Calibrator
9. Shock Absorber Tester
10. Booster Tester
11. Dynamic Balancer
12. Headlamp Focusser
13. Magnetic Crack Detector
14. Radiator Flow Tester
15. Speedometer Tester
16. Generator & Regulator Tester

The 'TVS' Service Stations have good teams of qualified and factory trained mechanics, Foremen, Engineers, Managers and other officers for their systematic and organised operations. Thus, the chain of Service Stations is able to provide excellent and most modern service facilities to Automobile owners and Fleet operators of South India. The Organisation employs over 2,000 trained workers and staff at their five Service Stations.

There is a well-equipped Service Training School at Madurai Service Station, wherein, Short term courses in Automobile construction, Repairs and Maintenance are conducted to impart practical and theoretical training to promising young mechanics. The duration of such courses on various subjects connected with this Industry, ranges from one to four months.

The bus and lorry body building activity of 'TVS' has expanded and now over 800 bus bodies are built every year, to suit the customer's requirements on any type of chassis, available in the country.

The 'TVS' entered the field of 'Road Transport Industry' in South India early in 1912 when the first bus was put on road in Madurai City. It was owned and operated by the late Sri T. V. Sundaram Iyengar, the Founder of the Organisation. In 1946 Messrs. Southern Roadways Private Ltd., was formed as a separate Unit to manage exclusively the bus and lorry operations. At the present time it possesses about 340 buses and 150 lorries, covering about 45,000 miles per day, in Passenger Transport and about 19,000 miles per day, in Goods Transport—the biggest Road Transport Under-taking in South India. Early in 1943, Tyre Retreading work in large scale, was undertaken by another Unit of the 'TVS', Messrs. Sundaram Industries Private Ltd., which has its station at Pudukkottai, Coimbatore, Madras and at Bangalore.



TVS Service Station, Madurai

In order to encourage and assist small fleet owners, who are ambitious to expand their activities M/s. Sundaram Finance Private Ltd., was formed in 1954. The customers particularly the small Fleet Owners are provided with credit facilities on Hire Purchase basis on easy and covenient terms.

In 1949 under the "Motor Vehicle Insurance Scheme", 'TVS' organised and established M/s. Madras Motor & General Insurance Co. Ltd. The Company also deals in Fire and Inland Marine Insurance, in addition to Motor Vehicles Insurance Scheme.

The 'TVS' has recently entered into the manufacturing scheme of automotive electrical parts in collaboration with M/s. Dunlops and M/s. Lucas of England, respectively. The plants are being erected at Madras.

13 WAYS TO KILL OR CURE A FORK TRUCK

By Robert S. Leaf, New York

WOULD you pour water into a fork truck's gas tank? Would you send a fork truck out on a job without a drop of oil in it? Would you put anti-freeze into the radiator on a hot July day?

May be *you* wouldn't. But apparently some people do. According to Clark Equipment International, major manufacturer of fork trucks, a study of the nature and cause of fork truck ailments indicates that such actions are responsible for at least 10 per cent of fork truck damage.

The cause, obviously, is plain carelessness. And combatting carelessness is a difficult task. Rather than giving stern lectures and issuing dire warnings, Clark has taken the opposite approach and made available an " easy to follow checklist of things to do to kill a fork truck ".

" Perhaps," Clark says, " by pointing out how easy it is to damage a fork truck through carelessness we'll reduce the 'human errors' that are costing industry throughout the world thousands of dollars a year ".

WAYS TO KILL A FORK TRUCK

THE KILL

(Things you should *not* do)

1. Ignoring the manufacturer's lubrication specifications is an easy and sure way of doing permanent damage to a fork truck. A bad move is to use one kind of lube for *all* lubrication. Chassis grease, for example. This probably won't hurt the chassis but will certainly hurt the engine, steering gear, lift chains and other parts requiring lighter oils.

THE CURE

Be consistent about following the manufacturer's suggestions for lubrication, regarding both the type of lube to use and the frequency of lubrication.

THE KILL

2. When looking for a container with which to fill the gas tank, pick up the water can. But don't look inside. There might be an inch or two of water left in the can. If this is poured in the gas tank, eventually the engine will stop. Perhaps no serious damage will be done, but several hours might be spent looking for the trouble.

3. The removal of both tilt cylinders for periodic inspection presents a fine opportunity for ruining the truck's upright. This can be accomplished by removing the cylinders without first securing the upright. When the second cylinder is taken out, the upright, having no further support, will crash to the floor.

4. Rubber gaskets and seals, although small, are important to proper truck operation To hasten the failure of such parts, clean them in cleaning solvents with a mineral base. This will cause the rubber parts to become tacky, soft and swollen and generally unfit for use.

5. If the master brake cylinder is scored and pitted, brake operation will be faulty. To do a good job of scoring the cylinder, polish it with emery cloth or sandpaper. These will permanently scar the cylinder.

6. A crack in the cylinder block is usually considered major damage. To accomplish this, wait till the engine overheats, then immediately pour cold water into the radiator. If the engine is hot enough and the water is cold enough, the cylinder may crack.

7. Cold weather provides excellent opportunities for damaging fork trucks. For example, if the cooling system becomes frozen solid, start the engine immediately and run it at high speed. This could cause extensive damage to the radiator, cylinder head, block and just about everything else.

THE CURE

Use a can that's used for gasoline only, not water or oil. And make sure it's clean and dry; dirt in the gas tank will cause more harm than water.

Use a mobile crane, chain lift or some such device to secure the upright when the tilt cylinders are removed.

Clean rubber parts in denatured alcohol or some other non-mineral solvent.

Always use crocus cloth to clean cylinders of pressure marks and discolorations.

When engine overheats, do not add water until the engine has cooled. Then start the engine and add water slowly.

Never start the engine when the cooling system is frozen. Tow the truck to a warm building and let it thaw completely.

THE KILL	THE CURE
8. Another cold weather trick is to add water to the battery when the truck is operating in freezing temperatures. Since the water can't mix with acid, it will probably freeze, perhaps cracking the battery case.	Let the truck, or at least the battery, warm up before adding battery water in very cold weather.
9. Additional damage to the battery can be done by always filling it full of water rather than just to the water line plainly marked inside each case. With too much water the battery will boil over readily, thus allowing battery acid to corrode metal parts.	Fill batteries with water only to the level indicated inside the case by the manufacturer.
10. When adjusting the distributor, don't worry about maintaining proper gap between points. A few tenths of an inch difference will throw the distributor off timing and effect the performance of the whole engine.	For smooth and reliable performance it is of utmost importance that proper point gap be maintained. (For measurement, a wire feeler gauge is more accurate than a flat gauge.)
11. Since moisture in the ignition coil will make the coil inoperative, always steam clean the coil, or better yet, dunk it up and down a few times in water. This will cause rust and corrosion and considerably shorten the life of the coil.	Never get an ignition coil wet. Use an air blast to clean out dust.
12. Upright damage can be accomplished by neglecting to adjust tilt cylinders so that they give an equal degree of forward and backward tilt. If tilt is not equal, one cylinder will reach its travel limit ahead of the other cylinder, causing the upright to bind. Consistent wear of this type will permanently warp the upright.	Periodic inspection will indicate whether tilt cylinders are functioning equally. Deviations should be corrected immediately.
13. Through the simple expedient of keeping the fan belt too tight, there's a fine possibility of a) breaking the fan belt, and b) exerting enough side thrust on the water pump and generator bearings to cause premature wear.	Adjusted correctly, the fan belt should have about one inch of free play.

Diesel Development in medium and Small Commercial Applications

By J. G. DAWSON
Director of Engineering,
F. Perkins Limited, Peterborough, England.

THE general use of the diesel engine in Europe has spread to smaller and smaller commercial vehicles until light delivery vans are available fitted with 99 cu. ins. diesel engines as first equipment. For a number of well known reasons this has not yet happened in North America although there is now considerable evidence that the same trend is starting here. This paper makes the basic assumption that this trend is inevitable and discusses only the factors which are likely to affect the rate of adoption of diesel engines below 400 cu. ins. capacity in the smaller vehicle and industrial applications.

A number of papers have been presented recently to the SAE dealing with the economics of various diesel engine applications in general and it is not necessary to go over this ground again other than to state that the first cost of the engine installation is the most important single factor in determining the economic justification of the diesel in any given application.

The necessary prerequisite to a widespread displacement of gasoline engines is the availability of suitable diesel engines. Until the time when diesel engine sales become an appreciable proportion of the gasoline engine sales in any vehicle, the transmission characteristics and the installation requirements will be dictated by the gasoline engine used. The diesel engine therefore must :

1) Be suitable for installation in existing vehicles without major changes to transmission, sheet metal, etc.

2) Have performance characteristics, size and weight similar to gasoline engines.

3) Have fuel consumptions sufficiently low to offset within a reasonable mileage the inevitable cost increase of the diesel installation.

4) Have as low a first cost as possible.

It is unfortunate that the essential differences between the diesel and gasoline engines make these requirements more difficult to meet as the engine and vehicle size is reduced but despite this the development of the diesel engine has reached the stage where it is a serious competitor in most commercial applications.

ENGINE CHARACTERISTICS

Engine Speed and cumbustion systems

The major factor in determining the suitability of a diesel engine of a given power is the engine speed at which the required power is obtained. In general in the past diesel engines have suffered from too low an engine speed to give an adequate operational flexibility and vehicle top speed but the maximum engine speeds now possible are such that they must be weighed against the requirement for minimum fuel consumption.

The limitation on engine speed is imposed as much by the combustion system as by mechanical design. Antechamber or indirect injection combustion systems have been developed which are capable of smoke-free operation at high b.m.e.p's up to and above the speeds at which gasoline engines are rated but which give specific fuel consumptions 10% are more greater than open chamber or direct injection systems. The latter, however, at their present stage of development, have a top speed limitation around 3000 rpm in cylinder bores of 3.5 – 5.0 inches because of an inability to control the air movement in the cylinder over a greater speed range without some unacceptable sacrifice at the lower speeds of fuel consumption or maximum torque. This makes it necessary in choosing a suitable engine to consider whether it is better to have an engine which will replace the gasoline equivalent without any alteration to the transmission ratios or whether the cost of a change in axle ratio to allow the use of a lower top engine speed is justified by the lower operating fuel costs.

These factors can be illustrated by considering two

similar engines of different maximum speeds, each of which is capable of powering a medium truck of 15,000—25,000 lbs. G.V.W. and whose characteristics are shown in Table 1. The Perkins Six 354 engine is an engine which will shortly be in production fitted with a fully developed direct injection combustion system and the Six 283 is an experimental version of the same engine with the stroke reduced to permit operating at higher rotational speeds and fitted with an indirect combustion system giving specific fuel consumptions which are good by the normal standards for such systems.

Fig. 1 shows the torque and fuel consumption curves for these two engines plotted on the basis of percentage of maximum speed. The close similarity between the two torque curves on this basis indicates that essentially the same vehicle performance can be obtained provided the transmission ratios are adjusted to compensate for the different maximum engine speeds.

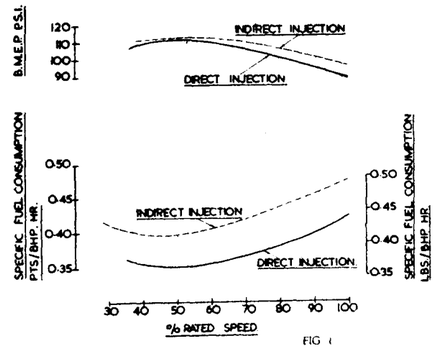


FIG 1

Fig. 2 shows fuel consumptions obtained from the road tests of a truck fitted with a Six 354 engine and operated with two axle ratios and over a range of total weights. It also shows a corresponding curve for tests with the Six 283 calculated from other results. Although the average speed of 26 mph is probably low for U.S. conditions the comparison will still be generally valid for higher speeds. At lower operating speeds the advantage of the direct injection system would tend to increase, and at higher speeds the difference in fuel consumptions would stay approximately the same. If the figures from these curves are taken for the case of a 20,000 lbs. G. V. W. truck, the direct injection engine shows a saving of about 27 dollars per 10,000 miles which well justifies the change in axle ratio necessary.

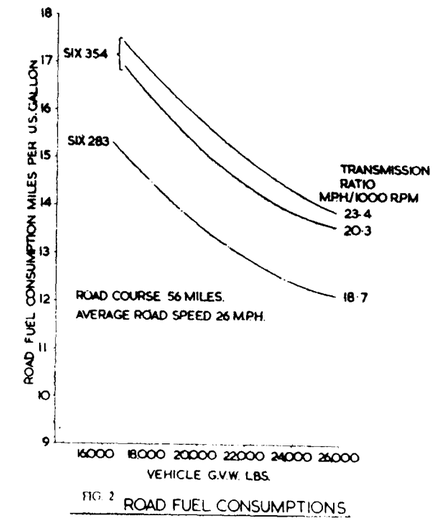


FIG 2 ROAD FUEL CONSUMPTIONS.

The better cold starting characteristics of the direct injection engine gives another reason for using a direct injection system if at all possible. However, there are applications where other considerations override the need for maximum engine economy such as in a vehicle fitted with an automatic transmission matched to a given speed range where the cost of making the necessary changes would be too great to be balanced by the improvements in fuel consumption. Should such applications become important an engine with the necessary speed range could be provided.

The above argument applies to the field of medium sized trucks but must not be extended too far down the range. Engines of capacity less than about 200 cu. ins. must operate at speeds above the present practical limit of 3000 rpm for direct injection combustion systems if only to allow sufficient power to be obtained from an acceptable engine size. The achievement of a satisfactory direct injection system is also increasingly difficult as the cylinder bore is reduced. There are therefore strong reasons for the use of indirect combustion systems on small engines.

Indirect combustion systems have now been developed which impose no practical limit on engine speed, operation of a production engine up to 5000 rpm with good efficiency being perfectly possible. Such a system is shown in Fig. 3. There is in fact no need for even the smallest diesel engines to

rated above 4000 rpm and the increased engine cost and reduced life which the higher speed would entail cannot be justified.

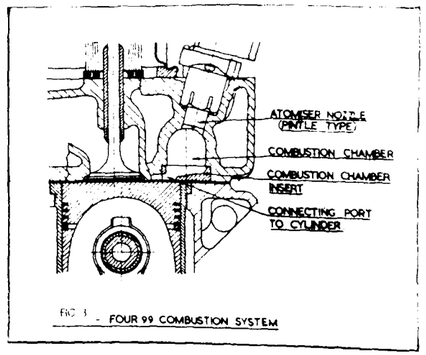


FIG 3 - FOUR 99 COMBUSTION SYSTEM

One other incidental advantage of this combustion system is that modifications are possible in some degree to allow the adaptation of the engine torque curve to suit the engine speed range required by a given application. This is illustrated in Fig. 4 which shows the performance of the standard version of the Perkins Four 99 engine together with the effect of changes to the combustion chamber volume and passage areas which could improve the low speed performance if an engine of limited speed range were required for industrial use.

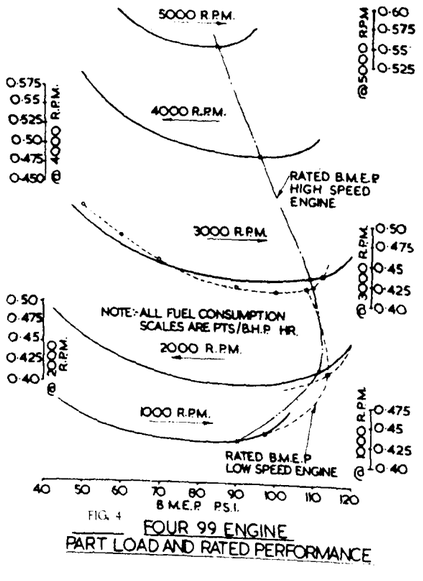


FIG. 4 FOUR 99 ENGINE PART LOAD AND RATED PERFORMANCE

Stroke Bore Ratio

The strong trend towards short stroke gasoline engines has greatly influenced the design of the engine compartments into which diesel engines must now fit without major modifications to the vehicle. Where the gasoline engines are vertical inline engines, their increased length has been to the advantage of the diesel engine. However, most of the installations under consideration are now fitted with V-8 gasoline engines, short and compact, which create increased problems for the conventional diesel.

One obvious answer to this from the diesel engineer is the development of V-8 diesels, and this is being done by a number of companies. It is not a good answer, however, particularly in the medium truck field, as the V-8 engine is inevitably more expensive than the inline six cylinder engine of the same power, and this increases the cost differential between the diesel and gasoline engine, which it is important to keep to a minimum. It is hoped that truck manufacturers will eventually keep this point in mind and give the diesel engine designer a little more length for his installation.

There is thus considerable pressure on the diesel engine designer to keep the stroke-bore ratio of his engine as high as possible to keep the engine length to a minimum. The major disadvantage of this, increased engine height, is generally easily accommodated in most installations and other important advantages support the feature of minimum length. There is no need to go into these in detail as they have been discussed fully by a number of others. It is sufficient to say that increased stroke-bore ratio gives improved thermal conditions, a more rigid cylinder block and head as well as more advantageous air swirl conditions in the cylinder for a direct injection combustion system. The engine torque output at low speeds is also improved.

An optimum stroke-bore ratio of 1.3 has been quoted in the past and our experience supports this figure.

GENERAL ENGINE SIZE AND WEIGHT

The smaller diesel engines have in the past suffered from the fact that they are design descendants of

larger more powerful engines used in applications where specific size and specific weight have not been of great importance. Over recent years, however, there have been notable advances in reduction in size and weight. Fig. 5 shows the improvements in Perkins engines in the 100-110 b.h.p. size during the last 20 years.

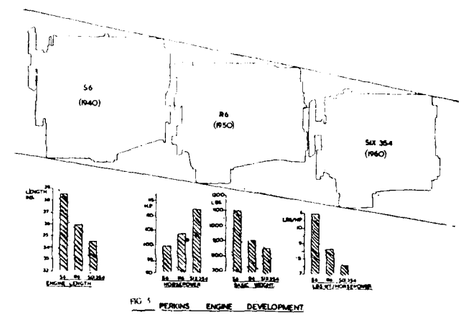


FIG 5 PERKINS ENGINE DEVELOPMENT

That the diesel is now becoming comparative in size with the gasoline engine is shown in Fig. 6. The American engine used in this comparison is not a high output new design but is a well established commercial engine which has powered many trucks and industrial applications.

Fig. 7 indicates that the same is true now for the smallest diesels. Here the gasoline engine is a present production British vehicle engine.

The measures taken to produce this situation have been many, each contributing in relatively small degree. The major has been the increase in engine speed and to a much lesser extent, higher mean effective pressures. On the design side, a better understanding of the internal engine stressing and improved materials have also enabled the engine structure to be reduced. Such features as wet cylinder liners must give way to dry liners which allow a shorter cylinder centre distance.

Although a considerable improvement has been achieved the diesel still lags behind the gasoline in respect of weight and will inevitably do so because of the higher internal loadings. If, however, the trend towards higher compression ratios continues much further in gasoline engines, which is doubted, this will make gasoline engine design approach more closely to the diesel.

Much more could be done in the application of light alloys to diesel engines, but there is little incentive to do so while quantities remain relatively low because of the increased engine cost. When the weight differences with the gasoline equivalents are as low as those shown in Figs. 6 and 7, they have so little effect on an installation that no increase in cost to obtain further weight reduction is justified at this time. In the future, however, pressure to reduce weight further is bound to increase and the introduction of light alloy engines particularly in the smallest sizes will come.

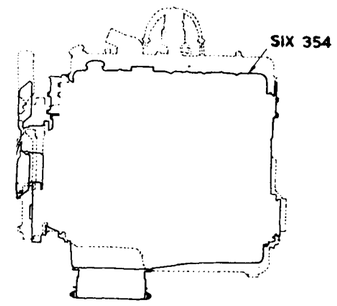


FIG. 6 SIX 354 ENGINE COMPARISON WITH TYPICAL U.S. GASOLINE SIX CYLINDER IN-LINE TRUCK ENGINE WITH 85% SIX 354 HORSEPOWER OUTPUT
SIX 354 BASIC ENGINE WEIGHT:- 854 LBS
TYPICAL U.S. GASOLINE ENGINE WEIGHT:- 820 LBS

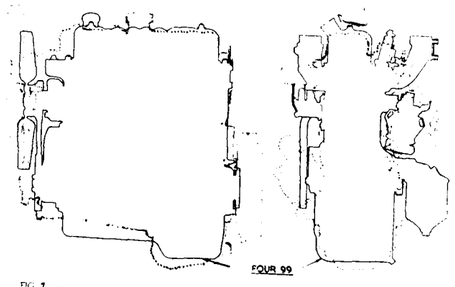


FIG. 7 FOUR 99 CAR & TAXI ENGINE COMPARISON WITH COMPETITIVE ENGINE OF SAME OUTPUT
FOUR 99 INDIRECT INJECTION ENGINE DETAILS
BORE:- 3·0 INS. STROKE - 3·5 INS. CUBIC CAPACITY:- 99 CU. INS
FOUR 99 ENGINE BASIC WEIGHT - 320 LBS
COMPETITIVE ENGINE BASIC WEIGHT - 395 LBS.

INSTALLATION

Many diesel conversions have suffered severely through bad installations, and it is important that the special problems in the installation of a diesel engine are given sufficient attention. If this is done, a diesel installation can be just as satisfactory as a gasoline.

It is rarely satisfactory to mount a diesel on the same engine mountings as used for a gasoline engine. Softer mounts are required and provision must be made for greater engine movement at low speeds. Satisfactory arrangements, however, are well established for most applications.

In respect of cooling, the diesel, particularly the direct injection engine, has a considerable advantage over the gasoline in lower heat rejection but this advantage can be easily lost. The gasoline engine has a considerable tolerance for overheating which the diesel engine has not and this emphasizes the need for ensuring that the cooling in any conversion installation is adequate. The difficulties when they do arise in a diesel installation are generally due to inadequate clearance round the fan and restrictions in the release of the cooling air from the engine compartment.

Air cleaners, fuel systems and similar features demand treatment which differs in some degree from gasoline practice. This presents no difficulty if past experience with diesel engines is followed.

ENGINE COST

The whole justification for the fitting of a diesel engine is economic and the first cost of the engine and installation is of prime importance as it determines directly the payoff in any application.

While the diesel is inevitably more expensive than the gasoline engine because of the increased loadings and the cost of fuel injection equipment, many diesel engines are unnecessarily expensive for a large number of commercial applications. Although it is inherently a long life engine, diesel designs have attempted to achieve the maximum possible life and mileages of 250,000 without overhaul are commonplace. This has in fact become a requirement in certain applications in the heavier class of vehiles but this philosophy should not be extended too far for smaller vehicles. Rather is it necessary to balance engine and vehicle life so that excessive cost is not built into the engine. This is not intended to imply that cost cutting on the engine should be carried out to the extent that the engine life is impaired but the inherent longevity of the diesel is such that an engine life very little less than that quoted above and more than adequate for the smaller trucks can be achieved while keeping a reasonable first cost.

Another factor which has kept the diesel engine cost high in comparison with the gasoline has been low diesel production quantities. Thus, there is scope for the independent diesel manufacturer to aggregate the requirements of a number of vehicle manufacturers and justify the expenditure on tooling which will bring down the engine cost. Certain manufacturers have sufficient faith in the development of the diesel market to take this step and engines including the Six 354 are now coming on the market at a cost per horsepower which is considerably lower than has been offered before.

The third influence on excessive diesel costs in North America is that in the larger volume vehicles diesel engines have only been available as conversions and not as first equipment. Even where a major manufacturer has offered a diesel it has had to be handled as a conversion. This entails unnecessary handling and modification charges and does not allow full credit being given for the displaced gasoline engine. The only relief from this excess cost is for the diesel alternative to be treated equally with the gasoline and engineered and assembled completely as a line production job.

The designer and development engineer must make maximum use of modern manufacturing methods, where quantities allow. Shell moulded and fabricated valve rockers, high pressure injection pipes and sintered metal parts are examples of components on which substantial costs reductions have been achieved by design and development and the introduction of the distributor type fuel pump has also assisted. It may be necessary in some cases to use more expensive components for certain parts in order to allow greater savings in others. An example of this is in the fuel pump drive arrangement of the Six 354 engine shown in Fig. 8. Here the fuel pump is driven from an engine speed layshaft through a relatively expensive 1 : 2 worm reduction gear in order to permit the use of a smaller air brake compressor or other auxiliary unit than the conventional half speed units previously used. As this arrangement gives an oil pump drive virtually for nothing, the overall saving is considerable despite the use of parts which are individually expensive.

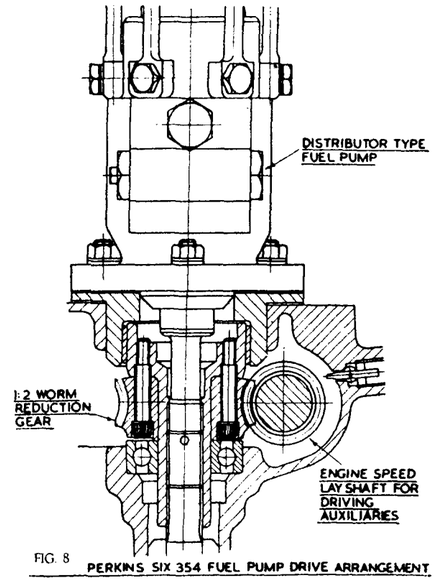


FIG. 8 PERKINS SIX 354 FUEL PUMP DRIVE ARRANGEMENT

It is interesting to note that in a number of recent SAE papers dealing with the economics of medium sized diesel engined vehicles, the excess diesel cost is usually shown in 1000 dollar units in the various graphs, implying that conversion costs are usually above this figure. In Britain the excess cost of the diesel over the gasoline engined vehicle is only a few hundred dollars and there is no reason why the same order of difference should not ultimately be reached generally in North America, as had already been done in those cases where engines matched to the installation have been offered by a vehicle manufacturer.

FUTURE DEVELOPMENTS

This paper has so far dealt only with some factors affecting the adoption of the present conventional four stroke diesel in existing vehicle types and some comment must be made on further trends. No consideration has been given to gas turbines or other form of new power unit as it is very unlikely indeed that these will be applied in the foreseeable future to vehicles requiring less than 250 b.h.p.

SUPERCHARGING

The present maximum engine output of 110—120 psi b.m.e.p. appears to be very near the limit of what we can expect from normally aspirated engines and major increases can only come from supercharging in some way. Turbocharging so far has been the main means of achieving this but of recent months there has been evidence of a loss of enthusiasm among engine manufacturers and operators for turbochargers on high speed engines. This has been due largely to increased maintenance costs partly caused by turbocharger troubles and it must be accepted that the turbocharger is not yet as reliable as the engine to which it is fitted. There is, however, no basic reason why these problems should not be overcome in the near future and there is no doubt that the turbocharged engine will become firmly established as a reliable unit.

The main demand for supercharged engines will come from those applications in which the installation demands a smaller engine for a given power, as the economics of the blown engine do not compare particularly favourably with those of the unblown engine under present conditions. Economics will impose a bottom limit to the engine size to which turbobluwing is applied particularly if more complicated control devices are necessary to give smoke free accelerations and suitable torque curves at all altitudes, as appears likely to be the case. This will probably be 200—250 cu. ins. Below this size, however, there will be scope for mechanically driven superchargers and there is a need for the development of more efficient and cheaper superchargers for this than are at present available. We are also likely to see the development of unconventional supercharging arrangements to give improvements over the present conventional torque curve, but these are only likely to be economic if accompanied by corresponding development in transmissions.

Intercooling is very attractive and its development will undoubtedly be combined with that of supercharging particularly in the larger sizes of engine.

COMBUSTION SYSTEMS

The limitations of the two main types of combustion system have already been discussed. Development of both systems will continue, particularly in the case of the direct injection system, towards higher engine speeds. Apart from this there is a real need for a reduction in combustion noise from all combustion systems and this will require much development work if the performance standards achieved by the various systems are not to be lowered.

FUEL

In considering the more widespread use of diesel engines attention must also be given to the fuel situation. Supplies of fuel to existing diesel fuel specifications are already restricted in a number of parts of the world, and any large swing in consumption from gasoline to diesel fuel in the United States is likely to lead to severe shortages. As a number of people have already warned, the normal development of diesel usage is likely to lead to a world wide shortage in due course if the present diesel fuel specifications are maintained.

No restriction on the more widespread use of the diesel can in fact be accepted. The diesel engine is the most efficient form of mobile power unit available today, and the great need to preserve the world's natural resources makes encouragement of its use essential. Some change to diesel fuel specification will therefore be necessary in the future, but this must be done to allow the economics of both engine and fuel to be as advantageous as possible while retaining the delicate balance of petrolem products.

It has been suggested that the best approach is to make the diesel engine omnivorous ; i.e., to make it a so-called " multi-fuel " engine, so that it can use other existing fuels such as motor gasoline. There is no basic difficulty in doing this as the steps necesssary to allow the diesel engine combustion system to operate satisfactorily on gasoline are reasonably well established. Such developments are proceeding for military applications but are not an economic solution to the problem in the commercial field. The multi-fuel engine must inevitably be more expensive and lose something in efficiency by comparison with the single fuel engine. The use of existing motor gasolines in the diesel engine is doubly unjustified in that the processing and additional components necessary to meet the requirements of the present gasoline engine are completely wasted and also the diesel engine would have to contain additional features to offset the effects of those characteristics which are advantageous in the gasoline engine.

All the advantages of the present highly developed diesel engine can be maintained if a wider cut is allowed for the diesel fuel. The JP4 type of gas turbine fuel works well in the average diesel and can be taken as an example of what is meant, altough the boiling range is probably wider than is necessary, and introduces complications due to the relatively high vapour pressure. It also has other specifications which are unnecessarily restrictive. A more limited increase in the lighter components, as has been suggested in India, is probably the best approach.

Although one major oil company contributed very substantially to the initial development of the high speed diesel engine through Sir Harry Ricardo, developments in diesel fuel itself have contributed very little to the progress of the diesel engine, and certainly nothing in comparision with the contribution that improved fuels have made to the gasoline engine. Improvements in gasoline fuels appear to be reaching their economic limit, and it is therefore suggested that the time has come for the petroleum companies to explore seriously the fields in which diesel fuel improvements might contribute to engine development, so that any specification changes necessary to allow the expolitation of these can be combined with the requirement for increased production.

Different performance considerations will have to be applied to the improvements likely from diesel fuels, as there is no over-riding technical criterion such as octane number. Because of the comparatively small amount of work done on the influence of fuel characteristics on diesel engine performance, it is difficult to specify the directions in which improvements can be expected. From the engine manufacturer's viewpoint, however, there is need for assistance from the fuel in obtaining better smoke limits, both hot and cold, and reduced combustion noise. It is likely that both these features could be improved with improved volatility and reduced ignition temperatures or ignition delay, but further research work is necessary to establish this and to investigate the changes in injection and combustion systems necessary to take advantage of the improvements. It would be too optimistic to expect major improvements in a short time, but even small improvements would be valuable.

Much work has been done by petroleum companies on the synthesis of particular ranges of olefins and aromatics to improve the quality of gasolines. A similar programme to cover paraffins is likely to pay handsome dividends later.

We would therefore make a strong plea for a much more strenuous programme by the oil companies on research into diesel fuels to overcome likely deficiencies in supply and at the same time offer the possibility of performance improvements. Most engine manufacturers would be very ready to co-operate in such a programme even to the extent of redesigning their combustion systems to suit new fuels, but the petroleum companies must take the lead.

An additional incentive to the oil companies must be the great concern being shown regarding smog in a number of important areas. The diesel engine contributes very much less than the gasoline engine to smog forming conditions, and the exhaust is also less toxic. When a diesel is in need of maintenance or out of adjustment, its exhaust is very much more unpleasant, but as it is at the same time very visible, it simplifies the control of atmospheric pollution, and all diesel engine manufacturers will support effects to keep genuinely bad engines off the roads. In the case of the gasoline engine the control of the unburnt hydrocarbons is likely to be very much more difficult. The best solution to the smog problem is the fitting, not of a catalytic muffler to a gasoline engine, but of a diesel engine in its place.

CONCLUSIONS

This paper has attempted to show that although the application of the diesel engine to medium and small commercial vehicles has been slow in North America, the availability of more up-to-date engine designs is likely to accelerate its adoption considerably. Engines are now available which have characteristics sufficiently close to those of the gasoline engines at present in use to allow of their installation without major changes in vehicle design. This being so, the major factor affecting the rate of adoption of the diesel is the cost of the installation. It is not possible to generalize on the pay-off mileage for the diesel, as this varies widely, depending on the engine, the vehicle, and the type of operation, but engine costs have been brought down to a level where very low pay-off mileages can be achieved, provided that the vehicle manufacturer is prepared to install the engine on the line. These mileages are still worth while when the diesel engine is fitted as a conversion.

The petroleum industry must recognize that the swing to the diesel engine is increasing, and make provision for the changes in fuel requirements by adequate research programmes.

Further engine developments are not likely to affect the situation to any great degree in the immediate future, but even so, the existing engines are adequate to see the diesel engine firmly established over the whole range of commercial vehicles.

TABLE I

Possible Engines for 15,000 - 25,000 lbs. G.V.W. Truck

Engine	Six 354	Six 283
Max. R.P.M.	2,800	3,500
Max. Power, B.H.P.	112	119
Combustion system	Direct	Indirect
Bore, ins.	3.875	3.875
Stroke, ins.	5.00	4.00
Cylinder capacity, cu. ins.	354	283
Max. Torque, lbs. ft.	260	210
At R.P.M.	1,450	1,850

The Automobile and its Place in Man's Prosperity

By G. Schofield, A.M.I.M.I.,
Quinton Hazell Ltd., Colwyn Bay, North Wales, U.K.

MUCH has been written about the automobile, and some writers have dealt solely with technical data, others have discussed it in relation with a nation's economy and prosperity. For instance, figures are often quoted of a Country's car population against the number of its inhabitants. In the writer's view the automobile is something quite unique. Many people who do not already own a car desire to, and indeed would go without other things to own one. The man who owns one seldom gives it up unless prevented by medical disability. So, to fulfil this primary need, the automobile is a complicated machine tool designed to give a man and his family a means of transport, in order to earn his living, and for his pleasure. Secondly, it is one of the status symbols. This fact is of tremendous importance to Manufacturers and to the people who eventually buy a car.

Now, to refer to the subject of car population, a subject which is vast, and linked with politics and economics; but to begin to understand it one must think of it on a personal level. In the period 1920 to 1940 the output of cars from a manufacturer was largely taken up in his home market, America being the only large exception to the rule. Since World War II, and in many ways as a result of it, the demand for cars, and the buying of them, is often thousands of miles from their manufacture. This now raises many problems, and many of them are far from being solved. Thinking of the automobile as a machine tool, a buyer is presented with many types, all of which are designed to give him one thing, namely transport. Now unlike a machine tool in a factory, a car is expected to suffer a certain amount of abuse; it must give unfailing service, and maintenance is something it rarely gets. It is inevitable, therefore, that the manufacture of automobiles, and in this context it means commercial vehicles also, should take place nearer to the buyers and users of them. In order to achieve this, there will have to be co-operation between the older established centres of automobile production, and the new factories which are being built in countries which have little experience of engineering production. Here the designers in the older plants have a duty inasmuch as the automobile must be suitable for the country in which it is going to be sold, also production techniques must be kept within the scope of relatively low production output, and yet it has got to be sold at a price which is competitive with similar vehicles of other manufacture.

The production of motor vehicles and tractors offers one of the quickest ways of increasing a nation's prosperity for this reason: Say a factory is established employing 5,000 people. This factory cannot be operated unless there is also created a vast network of feeder services and supplies. The first demand is for Universities and Technical Schools to train future managers and technicians. There is a vast demand for cast iron and steel in various forms, most of the common metals are required—glass, rubber and plastics, industrial gases. chemicals and paint. In addition, a supply of consumable tools and instruments are required. All these manufacturing processes again require managers and technicians. In this way it can be clearly seen that a manufacturing concern employing 5,000 employees will indirectly provide work for a additional 15,000 and so on.

When the automobile leaves the factory, the building of which has depended upon all these people, it then goes to be sold, to a garage, who sell it to a customer. He in turn pays a licence fee in one form or another, and insures it, so we find further people employed. As the car is used, so it has to be serviced and repaired, and fuel has to be bought. The employment thus created in turn brings further employment, and these people in turn become the buyers of automobiles and many other of the good things of life—houses, food, clothing, and adequate medical services. Indeed, in countries which have been manufacturing automobiles for some time, many families require now, not one car, but sometimes two, or even three.

The automobile engine is further developed for use on the land in agricultnral vehicles, Tractors, Harvesters, Binders and other machines. The horse power thus created will quickly transform poor agricultural land, with the use of right measures, into rich growing areas. Irrigation channels can quickly be dug, and mechanical pumps, again worked with vehicle engines, can irrigate large areas easily andeffectively.

It will be seen, therefore, that the automobile, besides being a status symbol of prosperity, is a prime means of making that prosperity. It follows from this that Governments in countries where the standard of living is low are encouraging indigenous manufacture of automobile components and engines, and must remove all barriers which prevent by reason of taxation, or withholding of licences, the establishment of an automotive industry. This policy is now being pursued in India, and the rich rewards of man's inventions are now making their presence felt in and on the land.

Alco pleased with Straight-line Progressive-station assembly

By A Special Writer

IT has been three years since Alco Products, Inc. modernized its diesel-electric locomotive manufacturing with a straight-line, progressive station assembly concept which has proven to be most efficient and workable. The modernization program was completed in 1958 at a cost of $4,000,000.

Heart of the new operation at Schenectady, N.Y., U.S.A., is a building which is 1190 feet long and is equipped with 13 cranes, including five cranes with capacities exceeding 35 tons and one with a capacity of 75 tons. In the assembly operation basic steel plate starts at one end of the building and moves down the line to emerge from the other end as finished, painted and ready-to-operate locomotives.

It is the only straight-line assembly facility of its type in the world.

BUSY SHOP — Poised for a minute over the three-track work area of ALCO's locomotive production shop, this Model 251 diesel engine soon will become the power plant of a new locomotive. The straight-line, progressive-station assembly concept cuts down on materials handling.

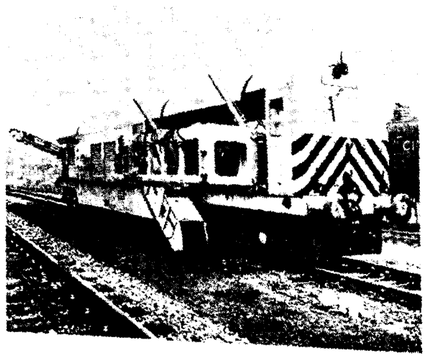
PAINT BOOTH — One of the final stages of locomotive manufacture is the work of the paint booth crew, where the new unit is cleaned, primed and then finish-painted with the colors of the railroad. Painting is done with spray guns after protective taping has been applied. Final touches, of course, will be by hand.

MULTI-LINE LOCOMOTIVE ASSEMBLY AREA — This is the area of the "finish" tracks in ALCO's straight-line, progressive-station locomotive assembly building, which was modernized in 1958 as the firm increased its production of diesel-electrics for railroads throughout the world. The locomotives being built here will continue on down the line to the final paint and test section. At the opposite end of the building (in the background of the photograph above) is the work area for fabrication of frames and trusses.

Ballast Cleaning Machine of Rolls-Royce

RESILIENCE of the permanent way depends on adequate drainage, which is impossible unless the supporting ballast is kept in a clean condition. A new unit built by the Hunslet Engine Company of Leeds and developed by them in collaboration with the North-Eastern Region of British Railways, mechanizes the task of ballast cleaning. The North-Eastern Region has recently taken delivery of the machine.

The machine can travel under its own power at 25/30 m.p.h. (40/48 km/hr.), from shed to operating site. When cleaning stone ballast at either or both sides of the permanent way, it can process 300 tons in an hour, which is equivalent to a speed of 600 yards (549 m.) per hour. The machine does not clean underneath the track, as the provision of thoroughly



Dirt disposer can be swivelled 90 degrees to either side, and retracted within buffer beam

(Continued from page A.17)

The building is divided at the middle into two main work areas, which have materials flowing into them at designated side-bay and center-bay points from supporting buildings and receiving points. There is a minimum of materials handling to reach the proper assembly area.

An assembly line running up the center of the southern half of the building is used for fabricating locomotive floor frames and side trusses. Sub-assemblies for these major components flank the center assembly line.

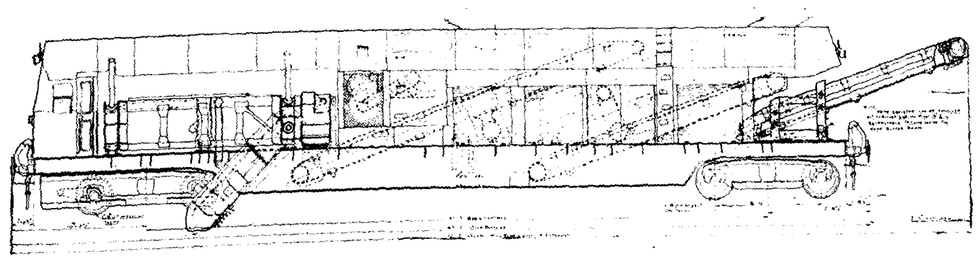
At the middle of the building is a main transverse aisle cutting across from one side of the building to the other. It is here that diesel engines, locomotive trucks, hoods and cabs are brought in.

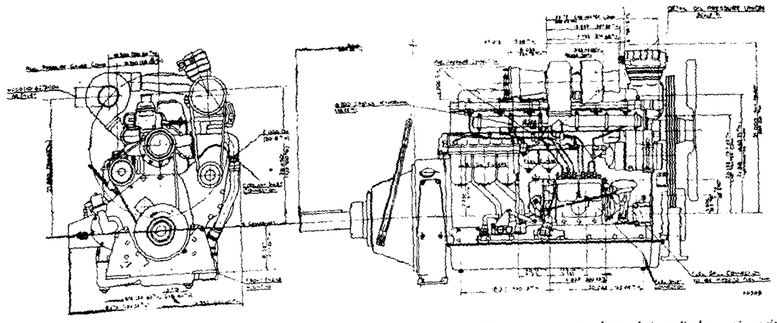
At the northern half of the building is the second major work area, where final assembly of the new locomotives takes place as the line moves from station to station along three separate " finish " tracks. There are additional sub-assembly spaces along both sides of the building, with final painting and testing being done at the extreme north end.

ALCO has found this modernized, straight-line locomotive production method to be efficient, economical and practical.

SUB-ASSEMBLY — This is the harness and electrical sub-assembly area adjacent to the major " finish " track work area. Contactor compartments, control stands and electrical boxes are readied here for installation in the new locomotives.

The firm has been in the locomotive business for more than a century. It manufactures a variety of diesel-electrics for railroads throughout the world.





Rolls-Royce turbo-charged six-cylinder engine with Rockford clutch

clean ballast at both ends of the sleepers permits drainage of rain water throughout the road bed to cleanse the centre section.

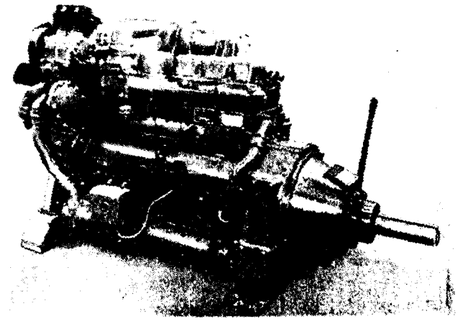
PRINCIPLE OF OPERATION

Ballast is picked up from the trackside by two digging heads, and transferred to a vibrating unit, where dirt is separated out and discarded. The cleaned ballast is returned to the track through a chute.

DESCRIPTION

The 80 h.p. motor which drives the vehicle's leading bogie, the two motors for the digging heads, and the motor for the ballast conveying belts are driven by four Deri-Sine duplex hydraulic pumps. These are driven from the main engine through a toothed belt and a Hunslet gearbox. Main power is supplied by a Rolls-Royce turbocharged six-cylinder engine (continuous rating 208 h.p. at 1,800 r.p.m.) transversely mounted in the vehicle. A manually operated Rockford overcentre clutch attached to the engine enables the drive to be taken up after starting.

The machine's two digging heads, retractable within the chassis when not in service, can be controlled



individually for speed and depth of cut. Ballast is collected by detachable hardened steel picks or tines on the caterpillar track of each digging head and conveyed along belts to the cleaning unit.

A dry-type double-deck vibrating screen containing mesh of suitable size comprises the cleaning unit. This is divided by a centre plate for independent cleaning of ballast from each side of the track. Dirt extracted by the cleaner is transferred along a belt to a

The Automobile Electrical and Fuel Systems
Its Importance, Operation and Maintenance

By J. M. Wadia
Premier Auto Electric Ltd.

THERE was a time when a car owner knew practically everything about his car. He knew what made it go and what should be done in case it stalled.

However, those simple days of "crank, curse and coax" have gone. The modern engine is an engineering marvel, a complexity of innumerable parts and several systems, each of which must work in harmony with the others to give top performance and economy.

Among the most important, are the ELECTRICAL & FUEL SYSTEMS; and the following figures reveal the astounding technical demands made on its components.

For every mile of driving.....
each Spark Plug has to fire 1,000 times, the Distributor Points open and close 8,000 times.

For every second.....
the Voltage Regulator may be called upon to switch on and off as often as 100 times.

Every time the Accelerator is depressed.....
10 to 15 parts start moving inside the Carburetor.

Each minute.....
the Fuel Pump must operate 1000 times during average driving speed.

The Carburetor has to meter or measure out the air and the fuel in the following proportion:

9,500 gallons of air to every gallon of fuel at part throttle operation;

7,500 gallons of air to every gallon of fuel at wide open throttle

(A hundred horse power engine consumes about 160 c. ft. air each minute)

Thus every unit of the system has to function accurately to give smooth power and high fuel mileage.

As a car is driven mile after mile, slowly but inevitably, its performance begins to fall off a little here and there. Everywhere, within the engine, precision parts are moving, wearing themselves and eventually departing from "New Car" specifications.

Hence the need of regular maintenance of each unit to bring the engine performance upto "New Car" standard cannot be over-emphasised.

Let us now take each unit and its function briefly.

BATTERY

The battery is the heart of the car's electrical system. It is necessary for starting, ignition, lighting and working other electrical accessories. It is not in itself, a source of electrical energy, but it stores and delivers the current, fed by the dynamo, accordig to the needs of the system.

The battery must be regularly serviced, i. e., its electrolyte level checked and topped up with pure distilled water, if necessary; also the battery the terminal should be cleaned and tightened regularly. The battery must be recharged whenever its gravity reads below half charged (1.175 or lower).

(Continued from page A.19)

disposal conveyor whence it is tipped either in a following wagon or, if desired, to one side.

When only the shoulder of the track is being cleaned, free passage is afforded for trains on the adjacent road of a double-track line.

The Hunslet ballast cleaning machine weighs approximately 65 tons and route availability on British Railways is high. There seems no doubt that other railway systems would be able to use machines of this type, with modifications to suit local requirements.

We are indebted to the North-Eastern Region of British Railways for permission to use their photographs in this Newsletter.

DYNAMO

The Dynamo generates and delivers the required amount of electrical energy to the battery, and the other electrical units of the car.

Since the Dynamo is driven by a fan belt, its proper operation depends on the correct size and proper tension of the belt, which must be adjusted as and when necessary. A loose fan belt means over-heating of the engine; low charging from dynamo, resulting in frequent running down of the battery.

A Dynamo needs periodical lubrication of its bearing and bushes, and cleaning of its commutator with sand paper.

REGULATOR

A Regulator is a very precision instrument controlling the output (voltage and current) of the dynamo, according to the requirements of the car's electrical system and the condition of the battery. A regulator consists of normally 3 units:

(a) The Cut Out acts as a switch between the Dynamo and the Battery. The Cut Out closes when the Dynamo voltage increases over that of the battery, and opens when the Dynamo Voltage falls below the battery voltage. A cut out not operating at the proper time may result in a burnt out dynamo and discharging of battery.

(b) The Voltage Regulator and (c) The Current Regulator, both, control the Voltage and the current output of the dynamo, as per the requirement of the system. A high setting of the Regulator may result in burning of light bulbs, distributor points or the dynamo itself; it can also damage the battery (overcharging). A low setting, on the other hand, can result in frequent running down of the battery (undercharging), poor lights and poor engine performance due to low voltage at the ignition system. Normally, a regulator needs very little attention, except the cleaning of the points and adjusting the settings of its three units. The adjustment must be done with the help of a very accurate Volt Ammeter, because as slight a variation as one tenth of a volt can make all the difference in proper functioning of the unit, resulting in troubles stated above.

(Continued on page A.24)

STARTER

The Starter replaces the crank handle. It cranks the engine by the press of a button, or just the turn of the key. The bendix mechanism of the Starter automatically disengages from the engine flywheel once the engine is started.

Like the Dynamo, the Starter needs periodical lubrication of its bearing (bushes) and cleaning of its commutator.

The proper operation of the starter depends on the condition of the battery and the connecting cables between the battery and the starter. If the starter mounting bolts get loose or if the bendix mechanism gets stuck with the flywheel, it can result in severe damage to the starter motor. A sluggish starter results in poor starting of the engine, thereby wasting battery current and fuel.

IGNITION COIL

The coil is like a Transformer, it converts the battery voltage (6 or 12 V) to the high voltage (15,000 to 20,000V) required to fire a spark plug. A coil, as such, needs no maintenance except keeping its connections, clean and tight. There can be no repairs done to a coil and it must be replaced, when, it goes defective, or its performance drops down, as indicated on a reliable Coil Tester.

DISTRIBUTOR

As the name suggests, it distributes the high tension current produced by the Coil to the proper Spark Plug at the proper time (the cylinders of an engine are not fired consequently, but according to a set firing order, say, 1-3-4-2 or 1-5-3-6-2-4). The distributor also has a make and break mechanism which interrupts the Ignition primary circuit to induce High Tension current in the coil secondary. Over and above this the distributor has mechanical and vacuum mechanism for automatically advancing or retarding the timing of

TYRES

by D.L.Spurrier,
Dunlop Rubber Co. Ltd. (U.K.)

Bud-grafting with selected rubber trees is steadily producing enriched strains, which yield a higher quality latex. (Reproduced by kind permission of the Natural Rubber Development Board.)

Much has been written about tyres, describing the raw materials from which they are made, the processes of manufacture, the design characteristics and performance, but little has been said about the human effort involved, which in this push-button age is apt to be overlooked. It is therefore refreshing to consider tyre manufacture from this angle, describing briefly those intangible ingredients of skill, craftsmanship, patience and experience which go into the modern tyre.

It is probably true to say that no other part of a vehicle involves such a variety of skills as its tyres. This begins many thousands of miles away from the factory, in the sticky heat of the rubber plantations, where growers, by careful and patient grafting are continually striving to produce better strains of trees, which will yield a higher quality latex.

Back home in the laboratories, the chemists explore the possibilities of new materials and the technologists develop new compounding techniques; in the textile laboratories new fibres are assessed and here, even the metallurgist plays his part. The development engineers continue to design more modern machinery, often controlled by electronic devices, and the process control staff keep a vigilant watch over every step in the production cycle.

The tyre designer is continually challenged by the changing trend in vehicle design and, perhaps, his task is the most difficult of all. Modern science has provided him with a wide range of materials from which to choose, each with its own particular property and it is upon the wisdom of his choice, gained through years of experience, that the most practicable compromise is made.

In the factory itself, most of the processes are aided by modern machinery, but in assembling the various component pieces, it is still the skill of the tyre builder which may make or mar all that has gone before. In a car tyre there are between twelve and twenty separate pieces, while with a truck tyre there may be as many as sixty to eighty and it is the precision with which each is placed that ensures every component playing its own vital part satisfactorily.

To find out whether new constructions meet the service conditions for which they have been designed and to keep a check on standard production lines, an extensive and rigorous testing programme is followed. In a thunderous roar, a wide variety of machines in the Dunlop Test House relentlessly punish tyres to destruction, day and night, all the year round. Tyres are run overloaded, underinflated, over a series of slats which buffet the tyre mercilessly and sometimes

THE INTANGIBLE INGREDIENTS

over sharp 'stones'. Weights are dropped onto tyres from great heights to test casing strength, while another machine imitates an aircraft landing in cross-winds. Tyres are tested in heat to see how they would behave in tropical climates, or in refrigerators to imitate arctic conditions and, in many other diverse ways, tyres are put through their paces. The value of machine-testing is that it is possible to repeat a given set of conditions time after time and produce results quickly.

Another way in which tyres are tested is on a Proving Ground where many different road surfaces have been specially constructed, ranging from the smooth skid pad to stretches of rough pebbles, granite setts, sea-washed highly-polished pebbles, concrete constructed with suitable expansion joints and a cambered track. Tests on each of these surfaces, under controlled conditions, give valuable information about different aspects of vehicle controllability.

Although machine and proving-ground tests provide essential information, road-testing is still the final criterion in showing whether a tyre meets the demands of service. The Dunlop test fleet comprises cars, trucks, coaches, vans, motor cycles, even cycles, and experienced drivers travel hundreds of thousands of miles every year to wear out tyres. Vehicles are driven in the give-and-take of ordinary traffic along broad main-roads and through twisting country lanes. Road tests are often carried out overseas where drivers send their vehicles hurtling along the German Autobahn, the Jabbeke Motor-Road in Belgium, or the Auto Strade in Italy, round tortuous alpine passes covered with snow and hard-packed ice, or over 'roads' consisting of little more than tracks in the desert. In fact, closely controlled tyre tests are carried out under all conditions in many territories and the significance of the results is studied with great care.

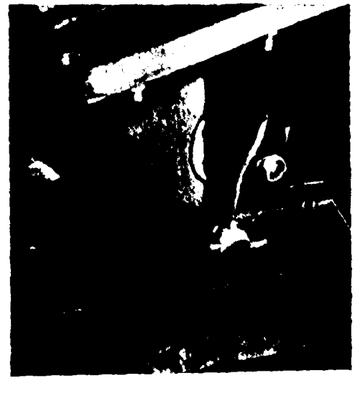
These then, are the ingredients of the tyres of today—raw materials, skill, craftsmanship and experience. What of tomorrow's tyres? The demands made upon them will become more critical as the years go by, for the rapid development of special motorways the world over will mean that sustained high-speed running will be common place, and is even now beginning to bring its own tyre problems.

We shall almost certainly see vehicles powered by gas turbine engines—there is talk of electronically-controlled vehicles and vehicles driven by nuclear power. Undoubtedly if these developments come about, they will each bring their particular tyre problems. The tyre industry is alive to all those possibilities and in its extensive training facilities, it is equipping the rising generation of tyre designers and builders who will benefit from the fund of hard-own knowledge and experience being handed down by the experts of today.

(Courtesy: DUNLOP GAZETTE.)

Above: A tyre builder assembles the component parts of a tyre.

Below: Plasticity tests being carried out on freshly mixed rubber compounds.



Right: An aircraft tyre covered with frost being removed from the refrigerator where it has been tested at extremely low temperatures.

(*Continued from page A.21*)

the spark according to the engine requirements, which depend on the speed and load.

The Distributor Points need cleaning and adjusting at regular intervals and are one of the most frequent causes of failure of ignition system. After adjusting the Distributor Points, road testing the car for checking and adjusting the ignition timing is a must, because the decrease or increase in point gap, respectively, retards or advances, the ignition timing. Wrong Ignition timing can result in anything from poor starting to harmful damage to the engine. Low mileage, lack of power, overheating, missing of the engine are common complaints due to improper distributor point gap or ignition timing.

The condenser in the distributor acts as a buffer and absorbs the current induced in the primary when the distributor points open. A weak or an improper capacity condenser decreases distributor point life. The faults due to a poor condenser are very hard to locate and hence a good condenser tester is a great boon in tracing ignition faults.

The Distributor Rotor and cap do the distribution of the high tension current. Their contacts must be clean. A cracked Rotor or Cap should be replaced immediately to prevent cross firing of spark.

The High Tension (H.T.) Wires, from distributor to spark plugs carry the high voltage (approximately 20,000 V) current and hence they should be replaced when found cracked or with weak insulation. Moist wires have a tendency to leak, so keep them free of oil and water.

SPARK PLUGS

The Spark Plugs play an important role of firing the mixture of air and fuel in the combustion chamber, under extreme conditions of temperature and pressure. Every engine takes different types of plugs according to its design, and it is very important that the selection of plugs is done with care to see that they are of: (a) the correct size (10 or 14 or 18 mm.) (b) correct thread reach (7/16 or $\frac{1}{2}$" or $\frac{3}{4}$" thread reach) and (c) the right heat value.

HEAT VALUE - HOT AND COLD PLUGS

The length of the insulator (which is not comparable or visible from outside) determines the heat value of the plug. A plug with longer insulator, takes longer time to cool and is considered a hot plug, or a plug with higher heat value. Similarly a shorter insulator means a colder plug because it takes less time to cool down. The heat value is obtained by studying the plug manufacturer's heat range chart and from the number stamped on the plug. (For example, in Prakash Plugs 14A 95P is hotter plug while 14A 225P is a colder one). If a vehicle has to do continuous long distance running, the colder plugs are normally recommended; while a car which does stop and goes city running, needs a hot plug.

Sometimes hotter plugs are fitted, to engines, which throw oil, to burn up the oil thrown on plugs due to poor rings. This is a temporary remedy, as ultimately the ring job is essential. Plugs must be fitted tight to avoid compression leak. Unlike other plugs Prakash Plugs do not need replacement of gaskets every time they are removed, because these plugs are fitted with specially designed gaskets. The top insulator of the spark plugs must be cleaned regularly to prevent leakage of current. The high tension wire must be fitted tight on the plug terminal.

The plugs must be cleaned every 3000 miles on a sand blasting machine (Spark Plug Cleaner). The central electrode of the plug must be filed flat, as rounded insulator, requires 50% more voltage to fire the plug.

Replace plug every 8000 to 10,000 miles by which time it has already fired 15 million times and is not half as efficient as new — because the insulator gets sufficiently weaker and the electrode wear is enough to warrant plug replacement. Modern high compression engine needs spark plug replacement every 5000 miles.

Loose and dirty connection is number 1 enemy of electrical system and hence it pays to check the connections—at the Battery, Starter Switch, Ammeter, Ignition Switch, Coil, Distributor, Generator and Regulator regularly for cleanliness and tightness. The earth connection between the battery, the engine and car body should also be clean and tight always.

FUEL SYSTEM

FUEL TANK: The tank stores the fuel which is delivered under pressure to the Carburetor, through Fuel Pipe, by the Fuel Pump. The only service needed by a tank is draining the fuel and cleaning the tank periodically. Of course, the leakage in tank by fuel lines must be attended to immediately unless you can afford pouring petrol on the road.

FUEL PUMP: Most of the cars are fitted with mechanical fuel pumps, but some English makes have electrical pumps also.

Mechanical pump consists of a diaphragm, worked up and down by a rocker arm which in turn is operated by the eccentric of engine cam shaft. On the downward movement of the diaphragm a vacuum is created to draw fuel from the tank; on the return stroke the diaphragm is pushed upwards, forcing the fuel from the pump to the carburetor.

Electrical Pump operates on a similar principle except that its diaphragm is worked on electromagnetic effort. The electric pump carries a distinct advantage—since it is operated on battery current, it starts functioning the moment the switch is turned on; while a mechanical pump can only operate when the engine is cranked and hence it takes time to start supplying fuel, thereby increasing the load on battery due to delay in starting of the engine. During summer, mechanical pumps tend to fail due to vapour lock in the fuel system, whereas an electrical pump is normally unaffected by heat.

Both the types of pumps need periodical overhauling, to clean dirt and gummy deposits, and replacement of the diaphragm if found cracked. The electrical pump also needs occasional cleaning of points (make and break contacts).

A poor connection or bad joint in fuel pipe line affects the performance of the pump considerably.

CARBURETOR: It is a device for breaking up fuel into very fine particles (atomisation) and mixing it with air in varying proportions to meet the variable conditions of speed and load on an engine. Thus it is a metering instrument. The mixture of air and fuel is drawn inside the cylinder by the vacuum created during the suction stroke (piston travelling from top to bottom of the cylinder).

A carburetor needs regular cleaning to remove dirt and gummy deposits, which can block its delicate passage and precision drilled jets. At the same time various adjustments like float level setting, accelerator pump setting, choke setting, etc. are also needed to get the best out of this precision unit.

Regular adjustments of the engine idling speed is essential, because a fast idling speed results in waste of fuel, while a slow idling means frequent stalling of the engine.

Using one step leaner jet in carburetor helps to get better mileage but at the cost of proper pick up. Too lean a mixture results in burnt engine valves and may result in harmful engine knocks. Driving with mechanical choke on, or an automatic choke that is stuck, is wasteful on fuel and it also increases engine wear because the flooding of petrol washes the film of lubricating oil in the cylinder.

AIR CLEANER: An engine consumes a lot of air—9500 gallons of air to every gallon of petrol at part throttle; 7,500 gallons at wide open throttle. All this air going inside the engine must be free from harmful impurities like foreign particles of dust, dirt, etc. and this is where the air cleaner comes to play a very important role of saving the engine from undue wear and tear.

An air cleaner is either (a) dry type where it contains a fine wire mesh, or (b) wet type containing oil—the air, sucked by the engine passes through the wire mesh or over the oil, leaving behind all the impurities.

The Air Cleaner needs periodical cleaning because a choked air cleaner reduces air supply resulting in lack of power and economy. A simple test to check air cleaner is to run the engine at idle speed and take off the air cleaner—if the engine runs faster now, the Air Cleaner is dirty or choked and needs cleaning.

EXHAUST: Just as a choked intake side (Air Cleaner) of fuel system affects power and economy, so does the exhaust side. A choked exhaust muffler (silencer) or badly flattened or bent Exhaust tail pipe, offers back pressure to exhaust gases (which should escape freely), thereby resulting in lack of performance.

A car may still run when a good many things are wrong with it, but the fact is modern cars need *Regular Maintenance* if they have to give your money's worth in performance and economy. Today's engine tolerances are very fine and compression ratios are higher. Therefore, it is very important to keep the modern electrical and fuel system in peak conditions at all times.

A Review of the Causes and Effects of Valve Troubles

Stem and guide wear; seat wear; overheating; sticking; guttering; burn-out; breakage; materials

By The Technical Department
Farnborough Eng. Co. Ltd.

SURPRISING RELIABILITY

CONSIDERING the terrific work that the valves of a modern engine have to do it is surprising that you, the repair men, are called upon so seldom to deal with cases of valve failure; premature valve failures do of course occur, but these can nearly always be traced to some particular contributory factor or factors rather than a defect of the component itself.

There are many possible fundamental causes of valve failure and there is a great deal that can be done to give the valves the best possible chance of a long life. It is your job to ensure that your customers have trouble-free motoring, and in this article we are setting down some of the more common causes and effects of valve troubles in the hope that they will contribute to your efforts.

Stem and guide wear do not in themselves constitute failure but they lead inevitably to it, because either the valve begins to seat incorrectly and consequently distorts, permitting gas blow-by and ultimate failure by burn-out, or it is subjected to a fluctuating bending moment which finally induces fatigue failure at the neck or head of the valve.

The main causes of high rates of wear are:

(a) Inadequate lubrication or dry operation during the initial period of running in. (when new or service valves are fitted, the stems and also the guide bores should be lightly oiled on assembly.)

(b) Failure of the lubrication system, or choked oil passages.

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RECOMMENDED SERVICE INTERVAL :

Every 3,000 miles	— *Clean* and adjust Distributor Points, Spark Plugs, and adjust ignition timing.
Every 10,000 miles	— *Overhaul* Carburetor, Distributor and Fuel Pump.
Every 10,000 miles	— *Replace* Spark Plugs.
Every 15,000 miles	— *Overhaul* Dynamo and Starter.
Every 20,000 miles	— *Replace* Distributor Rotor, Cap and High Tension Wires.

The toughest job in any engine is igniting the fuel at the right instant. Hot or cold, wet or dry, at sea level or 10,000 ft. above, the ignition and fuel system have to be ready to GO.

The difference between a genuine original replacement part and a substitue can be invisible to the naked eye, yet the substitute can never perform as well as the original and can even cause serious damage to a car. Remember, only your car manufacturer knows what is best for your car; so always select the parts which the factory has selected. Genuine original parts are the best value for your money.

Over 60% of breakdown on the road are due to faults in electrical and fuel system. The important thing is not to wait till one gets into the trouble. " Prevention is better than cure " is equally applicable to your car.

Finally, the right parts must be fitted by the right person—a specialist who knows your car well.

(c) Faulty valve train geometry or a cocked spring, both of which can cause excessive side thrust to be exerted on the valve. (Cocking of the spring may be due to faulty cotter assembly.)

Seat wear is influenced by very high unit loading and by certain mechanical conditions, the most significant of which are :

(a) Distortion of the port seat leading to wear because the valve tends to contact first on a small area of the seat and then to be forced into full contact by the explosion pressure in the cylinder.

(b) Similarly, adverse mechanical conditions, such as *malalignment* of the guide and valve with the port seat, aggravate abrasive action of the valve on the seat.

(c) If the material used for the port seat is incompatible with that of the valve, seat wear may result.

As seat wear progresses, a point is ultimately reached when gas leakage begins with further undesirable consequences.

Another factor that can lead to valve failure is overheating either of the engine as a whole or the valve head alone.

Considering the engine as a whole first, steam pockets in the cooling system or the build-up of sludge or scale at critical sections, particularly around the port-seat areas or in the radiator core, result in overheating which in turn may result in block and port-seat distortion.

Turning to the valve head, with the development of higher grade and leaded fuels and the use of higher compression ratios, exhaust valves operating under full, though not necessarily excessive, load are exposed to very high temperatures. In these circumstances maximum efficiency in valve head cooling is, of course, necessary.

As you know, most of the cooling of the valve head is done during the closed period through the areas of contact of the valve and port seats ; therefore, any reduction of the area or duration of this contact raises the overall temperature of the valve. It is possible for a valve to stick just before seating and to remain so until forced on to its seat by the gas pressure in the cylinder ; this delay may reduce the time of contact between the valve and port seat by as much as 60 per cent, with a proportional decrease in the rate of transfer of heat away from the critical zones of the valve head.

Three possible causes of excessive valve temperature you could warn your customers about are overloading of the engine, a broken fan belt, or late ignition timing.

But not only are unduly high temperatures liable to cause valve-head distortion, there is also a danger of combustion deposits melting. In a molten state, some deposits are highly corrosive and attack fiercely the valve seat and neck.

MOST COMMON FACTOR

This is one of the most common of the factors leading to valve breakdown and, unfortunately, is not always apparent in the initial stages, even to the most experienced mechanic. For this reason it is essential to understand the causes so that preventive measures can be taken on assembly.

The following factors can cause valve sticking :

(a) Insufficient clearance between valve stem and guide.

(b) Bent valve or badly scored stem.

(c) Worn guide or excessive clearance between the stem and guide.

(d) Excessive guide lubrication coupled with high temperature at the port end of the guide, causing carbon build-up.

(e) Excessive valve temperatures.

(f) Weak or broken valve spring.

(g) Sticking tappets.

The most freqnent cause of valve sticking is insufficient or excessive stem to guide clearance accompanied by deposit formation on the stem and guide. It is not always possible, however, to determine the order of events ; whereas initial deposit formation can cause the valve to stick, so also can a sticking valve accelerate deposit formation.

DEPOSIT FORMATION

If the valve stem area exposed to exhaust gases is subjected to unduly high temperatures there is a tendency for deposits to form. These deposits are combustion by-products from oil and petrol which become attached to the protective oxidised film of the valve steel and then build up. Eventually the deposit becomes compacted on the stem and takes up the essential clearance between the stem and guide. This causes the valve to become sluggish in operation and partial blow-by occurs. As a result, the engine temperature is raised and the operating conditions are aggravated until the valve completely fails to seat.

At this stage, blow-by begins to occur regularly with consequent burning of the valve head. Unless the resultant loss of engine power and efficiency is noticed and the remedy applied immediately, seat guttering is inevitable and is followed by complete failure of the valve and engine.

A chain of events has now been traced from several possible sources up to the point where the valve fails to seat properly and blow-by begins to occur. As we have seen, this latter state is associated with block, port-seat or valve-head distortion, or alternatively with some factor such as excessive deposit formation, which prevents the valve from closing correctly.

LEADING TO BURN-OUT

But before we go on to consider conditions leading to valve breakage, here are some other comments which should be made on conditions leading to valve burn-out :

(a) Block distortion and consequent port-seat distortion can be due simply to incorrect tightening of cylinder-head nuts. The engine manufacturer's instructions should always be followed.

(b) Valve-head distortion will almost certainly ensue, either directly or indirectly, from malalignment between the valve, port-seat guide, and will also occur as a result of port-seat distortion.

(c) Insufficient tappet clearance at normal operating temperatures prevents the valve from closing correctly, the clearance should therefore be checked at fairly frequent intervals.

(d) Seat leakage and distortion can occur as a result of overheating, if the ignition timing is too far retarded.

(e) Valve burning can also start from pre-ignition caused by incandescence of the deposits.

(f) Gas blow-by can occur as the result of the flaking away of deposits.

EFFECT OF FLAKING

Flaking usually takes place when there are considerable variations in the surface temperature ; this is because the deposits do not have the same rate of thermal expansion as the metal underneath. If the flakes of deposit become trapped between the valve and port seats, leakage will almost certainly occur, and valve-head distortion may result.

When the hot gas at high temperature leaks past the seat, through what is initially a very small channel, the temperature of the valve head is increased because the rate of heat transfer between the leaking gas and the seat is much higher than the rate of conduction through the metal-to-metal face-contact of the properly seated valve.

Again, it is increased because the leaking gases may tend to play rather like a blow-torch on the neck of the valve. These conditions can lead to distortion or, if this defect is already present, to further distortion—then guttering follows. Thus blow-by is increased and accelerates the process of burning and the final failure.

FATIGUE BREAKAGE

Brief mention has been made of valve breakage due to fatigue. The following additional factors all tend to increase valve seat impact velocities and loads, or impose some undue stress on the valve, and can therefore result in failure due to breakage.

(a) Excessive deflection or vibration in the valve train, and wear in the various components.

(b) Overspeeding of a c.v. or p.s.v. engine in low gear when it is being used as a brake on the hills. Under these conditions the valves tend to be thrown by the cam—valve bounce. Therefore, care should always be taken that the engine governor is correctly replaced if it has been removed during servicing.

(c) Weak springs or spring surge, which also lead to valve bounce, as does, of course, excessive speed in the indirect gears in the acceleration of cars.

(d) Enlarged tappet clearance ; the importance of maintaining the correct adjustments cannot be too strongly stressed.

Other factors which can lead to valve breakage are corrosion, as a result of high temperature (this can be the fundamental cause of metal fatigue, and certainly accelerates it) ; the trapping of hard deposit particles between the valve face and seat ; and small nicks or damage marks in the neck or stem—these can originate a fatigue crack, especially at high temperatures.

When an engine is being reassembled after repair or overhaul, it is wisest, because of the possibility of fatigue due to continual stressing over a protracted period, to replace valves that have already been in long service even if they have no visible defects.

Valve breakage, although relatively rare, is the most serious type of failure because of the severe damage it generally does to the engine. As we have seen this is generally brought about by fatigue. Once a crack is initiated the strength of the valve is seriously impaired and breakage follows without warning.

One last thing : when premature burning is experienced after only a small mileage and no apparent cause can be discovered, it may simply be that the material of the valve is unsuitable for the particular engine. Such a case might occur where a valve of material inferior to that originally specified by the engine manufacturer has been fitted during overhaul, or alternatively where special modifications designed to improve performance have been made to the engine.

Again, if an engine is operating continuously under exceptionally arduous conditions, a valve of higher quality than that normally fitted may be necessary.

Rolls-Royce Exhibits at the Second Indian Industries Fair at New Delhi

Rolls-Royce is exhibiting products from its Aero Engine, Motor Car, and Oil Engine Divisions, and is also showing models on behalf of its associate company, Napier Aero Engines Limited. The Company's stand is adjacent to the Society of British Aircraft Constructors' stand in the main British Pavilion.

ROLLS-ROYCE products have many applications in India, both in the air and on land. Widespread use is made of Rolls-Royce turbine aero engines by Indian civil and military aviation. In addition, the Dart prop-jet powers Indian built aircraft. The first flight of an Avro 748 transport built by Hindustan Aircraft Limited took place recently ; this aircraft is powered by two Rolls-Royce Dart prop-jet engines. On land, over four hundred Rolls-Royce diesel and petrol engines in India are operating in earthmoving equipment and shunting locomotives on major industrial projects, in fire appliances on airfields, and in railcars on the railways.

AERO ENGINE DIVISION

1. Rolls-Royce Dart R. Da. 7 prop-jet fully-sectioned to illustrate the internal design features of the engine.

Dart prop-jets currently power the two Vickers Viscount Type 730 aircraft in service with the Indian Air Force as VIP transports for the President of India and other senior Government officials. The Indian Airlines Corporation also operates ten Viscount Type 768 aircraft and five Dart-powered Fokker Friendships. The Corporation has a further five Friendships on order.

A fourth type of Dart-powered aircraft, the Breguet 1050 Alize carrier-based anti-submarine aircraft is also in service with the Indian Navy.

In December 1959 the Indian Government signed a licence agreement with Rolls-Royce for production

(Continued from page A.28)

of any or all versions of the Dart. These engines are to power Avro 748 aircraft likewise to be manufactured under licence in India for the Indian Air Force. The first of these aircraft, an Avro 748 Series 1 powered by Dart R. Da. 6 Mk. 514 engines of 1,860 e.h.p. completed its maiden flight at Chakeri, near Kanpur, on November 1st this year.

2. *Rolls-Royce Conway R.Co. 12* by-pass jet engine. Four of these engines, each of which develops 17,500 lb. take-off thrust (minimum rating), power the Boeing 707-437 aircraft of Air India International. Conways also power the 707 and Douglas DC-8 aircraft of a number of other airlines, including British Overseas Airways Corporation. More powerful Conway R.Co. 42 engines are under development by Rolls-Royce to power the forthcoming Vickers VC 10 and Super VC 10 long-range transports on order by B.O.A.C. and other airlines.

3. *Scale-model Rolls-Royce by-pass engine,* sectioned and rotating to illustrate the by-pass principle and the basic design features of the engine.

4. *Rolls-Royce Avon RA. 24 turbo jet* with reheat system and variable area nozzle. The RA. 24 has a take-off thrust basic (minimum rating) of 11,310 lb. which with reheat rises to 14,430 lb. Avons of a similar series (without reheat) power the Hawker Hunter F Mk. 56 ground attack fighters, Hunter T Mk. 66 trainer aircraft, and English Electric Canberra T Mk. 4 trainer aircraft in service with the Indian Air Force. Later marks of Avon with reheat also power the English Electric Lightning F.Mk. 1 fighters which entered service with the Royal Air Force early in 1961.

5. *Rolls-Royce powered VTOL aircraft.* Models of the "Flying Bedstead" used in early experiments on vertical take-off and landing (VTOL) techniques, and the Short SC. 1 VTOL research aircraft, and a hypothetical supersonic VTOL fighter. The Rolls-Royce "Flying Bedstead", which first flew in 1953, was powered by two Rolls-Royce Nene turbo jets of 3.2 : 1 thrust/weight ratio; it was employed in investigating control-jet stabilisation problems. The SC. 1 is powered by five Rolls-Royce RB. 108 lightweight jet lift engines of 8:1 thrust/weight ratio (four vertically-mounted 108s for VTOL and one horizontally-mounted 108 for normal forward flight), and in 1960 was the first British aircraft effectively to demonstrate vertical take-off, transition to normal flight, and vertical landing. The hypothetical delta-wing fighter could be powered by four ultra-lightweight jet lift engines of 16 : 1 thrust/weight ratio for vertical thrust and a by-pass jet for normal forward propulsion and efficient cruise flight.

OIL ENGINE DIVISION

6. Rolls-Royce model C8TFL diesel engine of eight-cylinder, turbo-charged configuration. This engine powers the Clayton shunting locomotive, a model of which is also exhibited on the Rolls-Royce stand. In this installation the engine is rated at 350 h.p. The engine also powers Aveling-Barford "SN" dump trucks in service in Britain, Chile, Spain and France. In this application the engine is rated at 400 b h.p. gross.

7. *Rolls-Royce powered shunting locomotive* in model form. This is the 0—6—0 diesel-hydraulic locomotive designed and built by the Clayton Equipment Company, and is powered by a Rolls-Royce C8TFL diesel engine rated at 350 h.p. coupled to a three-stage hydro-kinetic torque converter manufactured by Rolls-Royce Motor Car Division under licence from the Twin Disc Clutch Company, U.S.A. The 0–6–0 achieves a maximum tractive effort of 27,450 lb. and has a maximum continuous speed of 20 m.p.h. Locomotives of this type entered service in 1961.

MOTOR CAR DIVISION

8. *Light Aircraft Engine Department* Details are given of Rolls-Royce licensed manufacture of the Continental range of light piston engines for aircraft.

NAPIER AERO-ENGINES LIMITED

9. *Scale-model Napier Gazelle N. Ga. 13* turboshaft engine. The Gazelle has been developed specifically as a power unit for helicopters and is in service in Westland Wessex anti-submarine helicopters with the British Royal Navy. A model of the Wessex is exhibited adjacent. The engine being shown can maintain 1,450 s.h.p. for periods up to one hour. Other more powerful versions of the Gazelle are in production and under development.

INDIAN AIRCRAFT POWERED BY ROLLS-ROYCE

The close co-operation between Rolls-Royce and the Indian airlines and services is shown by the wide range of their aircraft which are powered by Rolls-Royce engines. The aircraft concerned are listed below:

OVER 200 INDIAN AIRCRAFT POWERED BY ROLLS-ROYCE

(a) Boeing 707–437 4 Conway Air India International
(b) Vickers Viscount Type 768 4 Dart Indian Airlines Corp.
(c) Fokker Friendship 2 Dart Indian Airltnes Corp
(d) Vickers Viscount Type 730 4 Dart Indian Air Force
(e) Breguet 1050 Alize 1 Dart Indian Navy
(f) English Electric Canberra T Mk. 4 2 Avon Indian Air Force
(g) Hawker Hunter F Mk. 56 1 Avon Indian Air Force
(h) Hawker Hunter T Mk. 66 1 Avon Indian Air Force
(i) Avro 748 Series 1 and 2 2 Dart Indian Air Force

NEW INVENTIONS TO AID AUTOMOTIVE INDUSTRY

By A Technical Correspondent

NEW ELECTRIC IMPULSE TACHOMETER

FURTHER development by Smiths engineers during the past year has resulted in the completion of a new design of engine revolution indicator WHICH REQUIRES NO DIRECT ELECTRICAL CONNCETION TO, OR INTERFERENCE WITH, THE ENGINE IGNITION SYSTEM AT ALL. Installation is very easily achieved as the battery feed cable between the ignition switch and coil is merely looped through an iron bridge projecting from the rear of the instrument case. This forms the primary side of a current or "triggering" transformer, the secondary winding of which is incorporated within the instrument case and is part of the transistorized, printed circuit "brain" which influences a D. C. voltmeter movement controlling the instrument pointer.

Ideally suited for use with spark-ignition engines having 4 or 6 cylinders, this new tachometer will be available early in 1962 for retail sales as an 80 mm. diameter instrument having a scale range of 0-7000 r. p. m. Extensive tests have been carried out with leading British motor manufacturers and at M. I. R. A., and this low voltage impulse tachometer will soon be specified as original equipment for a wide range of cars, in 4″, $4\frac{5}{8}$″ and 5″ diameter dial sizes.

The method of registering engine revolutions still utilises the frequency of the make and break of the distributor contact breaker. The current pick-up from the low voltage side of the ignition ensures instrument accuracy by employing as a triggering pulse the actual current required by the ignition coil to produce each spark.

As the primary winding of the triggering or current transformer is in series with the primary of the ignition coil, when the contact breaker closes, the current flowing to feed the ignition coil passes through the primary of this transformer thereby energising its core. When the contact breaker opens to provide a spark to the engine, the flux in the transformer core collapses and the core energy appears as a short duration voltage pulse across the secondary winding of the transformer. This triggers one of the transistors in the circuit which allows a second transistor to be switched on for a fixed time period thereby allowing current to flow from the battery to the voltmeter movement.

The instrument cannot be affected by eddy currents

(Continued from page 30)

in the H. T. side of the ignition circuit by the distributor contact breaker setting, or by erosion of the sparking plug points or excessive difference in gap settings.

NEW FUEL RESERVE VALVE

As its name implies, the new Smiths Fuel Reserve Valve guards against this mischance of running out of petrol. It makes provision for the last gallon or so of fuel in the tank to be held as a reserve; the driver can turn on a switch on the dashboard to bring the reserve into use, and an indicator light on the dashboard is illuminated whilst the reserve supply is being used. This light also, of course, serves as a reminder to turn off the reserve switch on the dashboard when the petrol tank is refilled.

Manufactured for original equipment purposes only, the fuel reserve valve can be adapted for fitting to all shapes and sizes of present-day fuel tanks and mounting into the bottom of the tank is achieved by the bayonet type tank unit fixing method introduced by Smiths at the 1960 Motor Show, and which is now tooled for quantity production. It is a solenoid operated device which is normally energised whilst running under full or MAIN TANK conditions and de-energised when on RESERVE thus providing a "fail safe" feature ensuring that fuel will always be available. Integral with the unit is a fuel supply line connection.

The valve is designed to retain 10-20% of the total fuel tank capacity as a reserve. In normal operation, fuel is admitted through an intake port at the top of the unit, which is some 2½" above the bottom of the fuel tank itself. To all intents and purposes, when the fuel level reaches this point, the vehicle has "run out of fuel". The driver however can drive on for a number of miles by operating a switch on the dashboard which opens a valve within the unit, permitting fuel to flow through the lower intake port. This is level with the bottom of the fuel tank and is surrounded by a fine wire mesh filter to prevent sediment entering the fuel line. Operating the fuel reserve switch on the dashboard also illuminates a reserve warning light, which remains alight until the reserve switch is turned off.

LOCAL OR "SPOT" COOLING EQUIPMENT FOR PASSENGER CARS IN HOT CLIMATES

The main feature of this stand will be a car body equipped to give a working demonstration of "spot" cooling. This system of cooling provides refrigerated air at fairly high velocity, discharged through adjustable aircraft-type nozzles to envelop the heads and chests of the car occupants in cooled moving air. The amount of refrigeration required is considerably less than with the hitherto conventional method in which the entire saloon temperature of the vehicle is lowered. Consequently the components of a "spot" cooling system can be smaller, easier to install, less expensive, and more suited to the medium-sized European car.

Smiths research expedition to the Tunisian desert in the summer of 1960 proved the efficiency of this new "spot" cooling system—a system which only requires one-quarter the refrigeration capacity of a full car refrigeration unit and which gives comparable comfort conditions.

Working on the vapour compression principle of refrigeration similar to that used for commercial and domestic refrigerators, the equipment consists of a compressor (driven from the engine) an evaporator box (in which the air is cooled) a condenser (for rejecting heat extracted from the air) an expansion valve, a liquid refrigerant receiver and a filter/driver. All these components are of small dimensions and could be installed under the bonnet of the smaller or "family" type of car.

Air from outside the car is cooled by blowing it through the evaporator box. It is then ducted to and applied at high velocity through nozzles similar to those used for passenger cooling in aircraft thereby providing moving air which envelops the heads and chests of the car occupants.

With air being supplied in this manner at some 20 cu. ft. per minute per person a temperature difference from each of the outlets of some 15°F below ambient can be achieved. When actual ambient temperatures are in the 100°F region this temperature drop gives a very real feeling of comfort. The air temperature can, of course, be regulated. As moisture in the air is extracted by this form of cooling the system will be eminently suited for use in those climates which experience conditions of high humidity.

Intended as an "optional extra" item, this equipment would need to be recommended by motor manufacturers for fitting to their products as installation of the air ducting required would need design consideration at an early stage of the actual vehicle design or manufacture.

NEW "TWO-UNIT" HEATER DEVELOPMENT

Further development of original equipment, full air blending types of car heaters has resulted in a "two-unit" system which has been specifically designed and tailored for the Ford Classic. Utilising a scuttle mounted combined heater matrix and blower motor in one unit, a separate air distribution box situated within the car interior is coupled to the matrix unit and completely independent control of entry of both heated and cold air from outside the car is possible. It also incorporates the well tried and proven feature of completely independent temperature control between screen and car which adds to driver and passenger comfort.

A scuttle air intake is employed which allows "cleaner" air to be drawn into the system since dust and fumes are not so evident as when the air intake is situated alongside the engine radiator. It is worth nothing that this equipment can be readily adapted to provide fresh air ventilation only and is therefore ideal for cars being exported to hot climate countries where car heating is not required. This then means that fresh air ventilation is available either by ram effect when travelling at speed or by blower "boosting" at lower speeds.

Control is by two quadrant levers on the dashboard which operate the positive sealing flap valves within the units themselves, thereby routing air to the required outlets within the car interior.

NEW THERMOSTATICALLY CONTROLLED ELECTRICALLY POWERED COOLING FAN

Added to Smiths Fan Coupling programme is the electric motor driven engine cooling fan actuated thermostatically by engine temperature variations. Normally whilst travelling at speed sufficient air passes through the engine cooling radiator for cooling purposes therefore the fan is not required. In slow moving traffic, for example, engine temperatures rise and the thermostat then falls for greater air circulation through the engine cooling radiator and switches on the fan.

As the fan is independently powered and is only driven when required, there results in an actual saving of engine power. Fan noise too is eliminated for long periods as the thermostat only calls for operation when the engine is running at higher than optimum temperatures.

THE R.550 REAR COMPARTMENT HEATER FOR UTILITY VEHICLES AND "MINI-BUSES"

Intended as an additional heating unit for passenger comfort particularly in Utility Vehicles and Mini-Buses the Smiths R. 550 Recirculatory Heater is installed in series with the existing heater fitted at the front of the vehicle for the drivers' use. It has a heat output equivalent to 5 KW of electrical energy, measures 13"×9½", can be fitted under a passenger seat in the vehicle saloon, and requires only two connections to the vehicles' cooling system and one to the electrical circuit via a variable speed switch. This switch controls the airflow through the heater unit thereby enabling the heat output to be varied accordingly.

Supplied in Kit form complete with sufficient lagged water hose, all unions, fixing bolts, switch, terminals, wire and detailed installation instructions, the Smiths R. 550 Recirculatory Heater is ideal for heating the interior of all utility vehicles and the increasing range of Mini-buses powered by water cooled engines. Operation is entirely independent of the drivers' heater and screen demister unit (where fitted).

For use during hot weather, the water supply from the engine cooling system can be turned off and the fan within the unit utilised for circulating the air within the vehicle interior creating the impression of a cooling, gentle breeze.

Retail price of the complete kit of parts for all applications is £20.0.0. 12 volt operation only.

NEW PACK FOR K. L. G. 'ACES'

Innovation for London Motor Show

The versatile K. L. G. FE 75 sparking plug, introduced two years ago specifically to meet the needs of family cars, used as much for town pottering as for open road fast touring, has become the ace in the K. L. G. range and, at the 1961 London Motor Show, will appear for the first time in its own special pack.

"The FE 75, with its wide engine-temperature tolerance, has proved to be ideal for practically all makes of popular cars" said Mr. J. S. Tryon, K.L.G. sales executive. "This plug alone accounts for more than 30 per cent. of all our car plug sales and is indeed our ace. Now it is a logical step to give it a pack of its own. It is recommended for more than a score of different British makes of car — something like 85 individual models — and sets of four in a special 'window' container will retail at £1 a set".

On the back of the pack are listed cars for which this "ace of plugs" is recommended. For the trader there is a winged counter display sales aid which also carries a complete recommendation list.

K.L.G. will also show a full range of sparking plugs, heater plugs for diesel engines and ancillary equipment such as waterproof plug covers.

NEW ALL-TRANSISTOR, PUSH BUTTON TUNING, PRINTED CIRCUIT CAR RADIOS FROM RADIOMOBILE

Three new car radios of an entirely new design are now in production by this Company. They are the first of their kind to be made in Britain and utilise the latest techniques available in high quality radio receiver manufacture. They are termed the 600 T, 601 T and 620 T series.

Compact in design and measuring 2" × 7" × 7" all three sets are for 12 volt operation and all give full coverage of the medium and long wavebands. As they are of "single unit" construction installation to most makes of car is easily achieved.

The 600 T employs 2 crystal diodes and 6 transistors in its circuit and gives an output of 3 watts. It is for "positive earth" installations only. Its counterpart the 601 T is identical in every respect except that it is for both positive and negative earth installations.

Retail price including purchase tax of the 600 T is £ 29.4.3.

Retail price including purchase tax of the 601 T is £ 29.9.5.

The 620 T also utilises 2 crystal diodes in its circuit but has 9 transistors two of which provide a push-pull output of 8 watts with only 3% total distortion. For positive and negative earth operation the 620 T retails at £ 32.16.0. including purchase tax.

All these sets have five push-buttons for pre-set station selection. Four of these cover the medium waveband. The remaining one automatically selects the long waveband and whatever station it is pre-set to receive. Control knobs either side of the push-buttons are for on/off volume, tone and manual tuning and a satin chrome facia surrounds the bright chrome framed tuning scale which is illuminated when the set is switched on.

Accessory Kits enabling "tailor made" installations to be effected to a wide range of cars retail at prices from less than £ 1.10.0. to £ 4.0.0. depending on the car and a range of aerials varying in price from £ 1. 17.6. to £ 2.12.6. are available. Loudspeakers to match the accessory Kits retail at £ 1.15.11. including purchase tax.

ARGON WELDING MACHINE

The "Iskra" Electric Equipment Factory of Ljubljana has begun to manufacture the "Tigvar" and "Migvar" Models electric welding units. These devices weld metals faster and more efficient than the old types and without the usual distortion and corrosion. Objects welded with the new devices need not be cleaned and finished after welding.

As distinct from "Tigvar", the "Migvar" welders are automatically fed with welding wire. It can weld four and more millimetre thick aluminium plates, magnesium and magnesium castings and stainless steel.

The PB 400 "Tigvar" welding unit is designed for hand welding. It is mounted on a mobile stand equipped with wheels and operate both on DC and AC current.

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Manganese toughens steel. American steelmakers have developed thousands of formulas to adapt their product of its 200,000 uses, and they keep adding to the list. For example, last year a steel company hopefully introduced coloured stainless steel on the market. It comes in eleven colours, applied by means of liquid plastic solutions.

With the reduction of high quality domestic deposits, the steel industry is turning increasingly to ore imported from Canada and other countries. Even so, sixty percent of the steel made in the U. S. is from indigenous ore. Since the beginning of the century, the industry has worked to find economical techniques for using ores which contain a lower percentage of iron of which there is no dearth at home.

The technology required to develop the immense taconite deposits of Minnesota was developed by the joint effort of several steel companies. Among all the rocks found on earth few are harder than taconite, but imbedded in it are iron deposits which had solidified in the ice age. To get at the 20 to 30 percent of iron thinly dispersed in taconite, men first had to learn to mine it. The jet piercing rig developed for taconite sinks blast holes in stubborn rock by means of a 4,300 degree flame of oxygen and fuel oil while sprays of water flush out particles of burned rock. Super tough alloy steels had to be made to forge the instruments for this mining operation.

Pittsburgh in the mineral heartland of Pennsylvania, was the nation's first steel city. A number of other towns rose to prominence as steel cities: Gary, Indiana; Cleveland, Ohio; Birmingham in Alabama, named after the British steel metropolis. Pittsburgh still produces a large part of the nation's steel, but pursuing the spreading market plants have been buit in 29 states. There are large steel mills in California and Texas, Utah, Kentucky and Maryland.

At different periods in the growth of the American economy, cotton and coal have occupied pre-eminent positions. 'King cotton' and 'King coal' have lost their royalty with the advent of man-made fibres and petroleum. Though steel, rugged and lasting, never was installed on a pedestal, it continued to supply the backbone to American industrial expansion.

The Development Programme for the Non-Ferrous Metals Industry

After three years of intensive study of conditions for the erection of new refinery plants and the reconstruction of existing ones at the Trepca lead and zinc mines and smelters, the development programmes are now being finalized. The basic object of the expansion programmes is to ensure the better utilization of raw materials and the attainment of a higher degree of finishing.

One of the most important projects will be the construction of a zinc electrolytic department of 18,000 ton capacity. Until now zinc concentrate alone was produced at Trepca.

The reconstruction of the lead smelter, whose capacity, upon the completion of the works, will amount to about 120,000 tons of crude lead, will also be an important undertaking.

Plans for the erection of a small iron ore reduction plant with capacity of about 75,000 tons of pig iron are also being prepared. The raw material for the iron would be the roast-sintered iron pyrite ores which remain after the production of superphosphates in the new factory which is now being completed at Kosovska Mitrovica. Conditions for the erection of a lead and zinc rolling mill for the finishing of these metals into tin, folios, strips, tubing and other products are being examined.

Separate departments for the production of sulphuric acid would be erected adjacent to some of these new projects, while the possibility of constructing a separate factory for sulphuric acid production which would be obtained from pyrite concentrates is likewise being examined.

A capital investment loan has been allocated to the Trepca enterprise for the construction of a new storage battery factory of a capacity of 6,000 tons annually. It is estimated that about 60 percent of this output would be sold on the domestic market, while the remainder would be marketed abroad.

(Commercial News of Yugoslavia)

RAILWAYS AND THE THIRD PLAN

THE Third Plan of the Railways has been formulated on the basis of an expected originating traffic of 245 million tons in 1965—66. This is 91 million tons more than what Railways handled at the end of the Second Plan.

In respect of passenger traffic the railway programme provides for an increase of three per cent per year in the non-suburban traffic. The increase in the suburban traffic is likely to be of a substantially higher order.

Of the total increase of 91 million tons of freight estimated during the Third Plan, 79.5 million tons are accounted for coal, steel and raw materials for steel plants, cement, iron ore for export etc. The remaining 11.5 million tons represent expected increase in general goods traffic.

The rapid development of the country' economy over the past decade has placed heavy demands on transportation system. The Railways, on whom the main burden falls, are handling today 100 per cent more freight traffic and 27 per cent more passenger traffic than they were handling before the commencement of the First Five Year Plan.

The main task during the First Plan was the rehabilitation of railway rolling stock and track renewal which had been subjected to great strain during the preceding years. In the Second Plan, in addition to making up the arrears of replacement, emphasis was laid on augmenting line capacity and procurement of additional rolling stock to meet the increasing demand for railway transport arising from the increased production in the agricultural and industrial sectors.

During the two Plans, the number of wagons, in terms of four-wheelers, has increased from 222,441 to 341,041, that of coaches (units from 20,502 to 28,171 and locomotives from 8461 to 10554. About 13,00 miles have been doubled and 800 miles electrified, 1200 miles of new lines added to the system and 400 miles dismantled during the war have been restored.

SPURT IN RAIL TRAFFIC

The originating traffic on the Railways has shot up from 91.5 million tons in 1950—51 to 154 million tons in 1960—61. The average load of freight traffic has gone up from 292 miles to 354 miles, during the period. In terms of tons originating, the volume of traffic has increased 69% and in terms of ton miles it has gone up by over 100 per cent. It has been recognised that the demand for transport has risen at a substantially faster rate than the increase in national income or the growth of production in any major sector of the economy during the period.

Difficulties have been experienced in the movement of coal particularly from the Bengal-Bihar coalfields. This is partly due to changes in the pattern of coal production and in the plans for supply of raw materials to the steel plants, resulting in longer leads for the Railways than were originally anticipated. To some extent it was also due to a short fall in some of the Railway development programmes, notably wagon procurment.

There has been relatively a much larger increase in suburban traffic than in the inter-city traffic carried by the Railways. The volume of suburban traffic increased from 4247 million passenger miles in 1951—52 to 7500 million passenger miles in 1960—61, that is, by 77 per cent as againt a 24 per cent increase in the over-all passenger milles during the period.

The Planning Commission envisages a review of the programmes for transport when the final report of the Committee on Transport Policy and Coordination is available. It is, however, recognised that during the Third Plan, the Railways will inevitably have to continue to carry the bulk of traffic in heavy goods—coal, iron ore and other materials for the steel plants etc. While there is a general shortage of transport in the country today, which is likely to continue for some time, this will not necessarily preclude competition between rail and road transport over certain routes and in respect of certain commodities. Consideration of Co-ordination will have a still greater