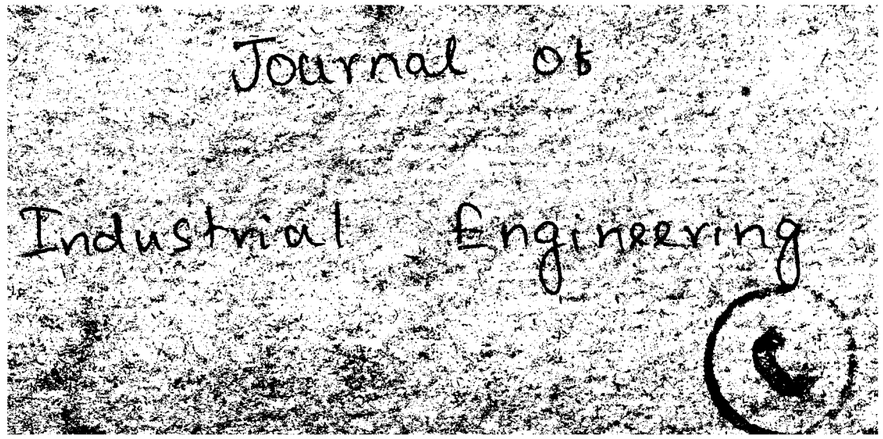

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CONTENTS

Spiral Heat Exchangers in the Wood Pulp & Cellulose Industries

By ADRIAN SELIGMAN

IN many large scale continuous industrial processes, the efficient recovery of heat from waste effluents and vapours is essential to economic operation.

An excellent example of the practical application of this principle is provided by the wood pulp and cellulose industries. In sulphite pulp mills large quantities of spent liquor are discharged from the digesters and this contains a very high percentage of the total heat which is employed in the process. Recovery of a large proportion of this heat by transfer to clean process water is effected in many installations by the use of efficient spiral heat exchangers.

Associated with some of these factories are alcohol plants which utilise the fermentable sugars from the waste liquor for the production of alcohol and various other by-products—distillation being an integral part of this by-product operation. This distillation process lends itself to further economies in heat by pre-heating the fermented liquor before it enters the column by means of the hot slop from the base of the column. The fermented liquor may, or may not, have been already pre-heated by condensing some of the overhead vapours from the top of the still.

Large surface area heat exchangers are sometimes used in the recovery batteries of sulphate pulp bleaching plants, even though waste water temperatures seldom exceed 120°F. In one such plant an amount of heat equivalent to 22.6 tons of steam per hour is recovered in the winter time from a waste water flow of 1,400 gallons per minute at 115°F, for a saving of some £ 63,000 per annum.

The diagram shows a Rosenblad blow steam condenser plant designed to recover heat from the large quantities of flash vapour which are liberated when a sulphate digester is blown. The hot condensate is collected in an accumulator tank and cooled continuously in a spiral heat exchanger, with additional spiral condensers for heat recovery from the end relief and the turpentine relief. In the latter case turpentine is obtained as a by-product along with the condensate.

SPIRAL HEAT EXCHANGERS

The Rosenblad spiral heat exchanger, manufactured in Britain by the A. P. V. Company Ltd., of Crawley, has certain advantages which make it particularly suitable for the recovery of low value heat. Among these are high fluid turbulence resulting in exceptionally high heat transfer rates with low pressure drops between inlet and outlet. The fact that the cold medium always flows through the outermost turns of the spiral means that heat losses due to radiation are negligible, and no insulation is needed. In most cases, moreover, there is counter current flow between the two media, which produces

Battery of Type 1 spiral heat exchangers for heat recovery between "new" and "old" sodium aluminate liquors, in a British alumina works

the highest possible mean temperature difference with consequent reductions in the area of heating surface required.

Owing to its compact design (approximately 2,000 sq. ft. of heating surface can be contained within a diameter of 6 ft. and a plate width of 4 ft.), the spiral heat exchanger may occupy as little as 1/10 the floor space of an equivalent tubular heat exchanger. It will fit snugly into a corner or between bends in a complicated piping system and may be mounted on trunions for easy cleaning. Alternatively

it can be installed in an elevated position—for example on top of a distillation column—with considerable savings in structural steelwork as well as in floor space.

Small portable units mounted on carriages are made and have been employed with success for the batch cooling of liquids. One such unit with an integral pump was used in an edible oil factory in Britain for cooling 1,000 gallons of fat from 300°C to 90°C every 3 hours in one vat after another.

THE BASIC PRINCIPLE

In construction the spiral heat exchanger consists basically of a flat sheet wound from the centre on a mandrel to form two concentric spiral passages. These are sealed from each other by closing one side of each central cavity and its associated passage, or both sides of one cavity and passage, depending on whether counter current flow or cross flow conditions are required (see Types 1 and 2 below). In some models spacing studs, welded on to the plate before winding, ensure a uniform distance between the passage walls and also serve in transmitting stress to the outermost turn or shell of the heat exchanger. Branch pipes are fitted to the ends of the passages and in the removable cover plates, which can be of various forms to suit liquid to liquid, vapour or sludge to liquid and vapour/gas mixture to liquid applications.

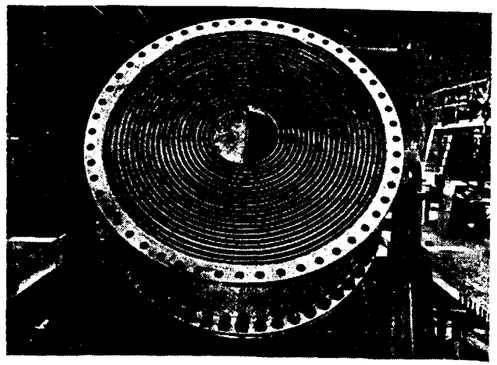
The spiral construction is inherently strong, so that pressure differentials of 150—175 p. s. i. can be accepted. The absence of any baffles or sudden changes of direction in the passages minimises the concentration of solids on the heating surfaces and allows controlled flow of both media at high velocities with pressure drops which may be as low as 6" w. g. for liquids and less than 1" w.g. for vapours. The sheet of which the spirals are made can be of any length, breadth or thickness to suit particular duties, while the width of either passage can be varied independently from 3/16 inch to 1 inch. Units with capacities of up to 300 tons of liquid per hour per passage are available.

When one of the media is a vapour such as steam, the high fluid velocity further increases the rate of heat transfer by reducing to a minimum the insulating film of non-condensable gas which tends to form on the heating surfaces. With clean liquors overall heat transfer rates of 500—700 BTU per hour, per square foot, per degree Fahrenheit—or 100% to 200% higher than in an equivalent tubular heat exchanger—are economically possible.

For viscous fluids the heat transfer coefficient is naturally lower, but it is normally possible to attain turbulent flow in liquids with a higher viscosity than is usual in tubular heat exchangers. Heat recoveries of over 90% have been obtained with hot waste effluents, and there have been cases when liquor going to waste at 100°F has been profitably exploited. Steam condensation rates of more than 50 million BTU per hour have been achieved in Type 2 and Type 3 units.

THREE MAIN TYPES

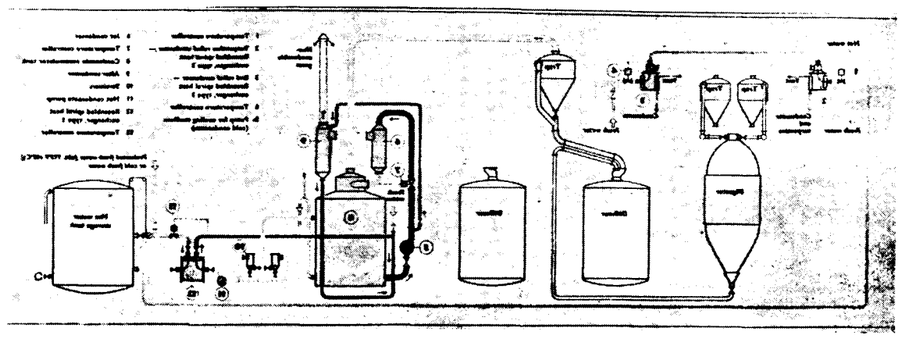
There are three basic types of spiral heat exchanger. The first has flat-faced covers on both the top and the bottom of the spiral body and is used mainly for liquid to liquid heat exchange. The hot medium



Aluminium alloy cooler for low temperature operation. Type 1 – top cover removed.

enters at the centre and leaves at the periphery, while the cold medium passes in the reverse direction. Both covers are removable to facilitate cleaning.

Type 2 is used mainly as a surface condenser for low pressure vapours, where the pressure drop must be kept to a minimum; it can also be used for the heating and cooling of viscous liquids. The passage carrying the cold medium is completely sealed, the other passage being left open; in effect, therefore, the body consists of a single hollow spiral through which the cold medium circulates, entering at one side and emerging by way of a branch pipe carried through the opposite side of the top cover. The two covers may be conical or cylindrical in



shape, forming additional chambers on either side of the spiral body, with a large branch in the top cover, through which the vapour enters and passes down between the coils of the spiral, condensing on its way. Condensate and non-condensable gases are removed through branch pipes in the bottom cover. In this design also, both covers are removable for cleaning.

Type 3 is generally similar to Type 1, in that alternate sides of each spiral are closed. It is used as a condenser where no serious limitations on vapour pressure drop are involved. The unit is fitted with a flat-faced bottom cover and a special vapour distribution head which allows free access by the incoming vapour to several turns of the inner spiral and ensures simultaneous replenishment of all the spaces where condensation is occurring. In this way a constant vapour velocity is maintained, and the condensing surfaces remain evenly and fully loaded almost to the outermost turn of the spiral.

The general direction of the vopour stream is nevertheless round the spiral from the centre to the outside, where uncondensed vapour and gas leave by a branch in the side of the shell, while the condensate is drained off at the bottom. The cooling medium enters at one side and leaves by a branch pipe passing through the centre of the top cover.

DETAILS OF CONSTRUCTION

Spiral heat exchangers, produced at the Crawley works of the A. P. V. Co. Ltd., are normally made of mild steel, stainless steel or monel metal; but copper and aluminium alloys, pure nickel and certain other materials can be used. The passages are sealed, either by means of a filling-in bar welded round the edges of the spirals or by bending over the edges of one or both plates and welding them together, with end plates welded into the sides of the central cavities.

Spacing studs, if required, are welded to the plates by the "stored energy" stud welding process, recently introduced to Britain by Kerry's Ultrasonics Ltd. They must, of course, be attached to opposite sides of the two halves of the plate, which are then welded together after being fitted into the mandrel for winding into spirals. In some cases, however—notably in the case of exchangers used for the pre-heating of sewage sludge—the studs are omitted.

In certain applications the liquid in one passage of a spiral heat exchanger may happen to be a convenient cleaning agent for scale formed by the liquid in the other passage. In such cases it is possible to arrange the various branches in such a way that the unit can be disconnected and reversed.

Every spiral heat exchanger manufactured by the A. P. V. Co. Ltd., is tailor made to individual requirements. Even so it will be found that these units are generally less costly than tubular heat exchangers, owing to their higher heat transfer efficiency, which allows reductions in heating surface area, with savings in both labour and materials, for a given performance.

Description of an Ore Crushing and Screening Plant Capacity 1000 t/h

By An Overseas Technical Correspondent

DUE to the growing demand for crude ore, several metallurgical works in Germany and abroad are faced with the question how to increase the existing blast furnace capacities. From the very beginning they were convinced that an increase of crude ore production could not be achieved by building up new furnaces.

It is well known that the ore coming to the smelting process in a variety of sorts—irrespective of its chemical analysis—is also very different as to the outer structure. One sort of ore is very coarse, whilst other lumpy ores contain a high amount of fines. The amount of fines in these lumpy ores may vary from 60—90%. Therefore, it is evident that a continuous gas passage across the charge cannot be obtained with a blast furnace containing ore of such a different composition.

In order to prepare the different sorts of ore for the blast furnace and sintering process, the metallurgical works have for increase of capacities already erected crushing and screening plants of :heir own. In these plants, the different sorts of ore will be crushed down to certain fractions and separated into lump material, which shall be held as cubic as possible for the furnace, and into fines for the sintering plant.

The ore crushing and screening plant described hereafter and built up by WEDAG Westfalia Dinnendahl Groppel AG., Bochum i/W., is fed with approx. 25 different sorts of ore with bulk densities of 1.6 to 3.2 t/m3. Most of these sorts of ore are covered by deliveries from Sweden, Brazil, Chile, Turkey etc., being relatively hard and dry. Furthermore, the feed material comprises ores from Venezuela and Labrador, which are partially wet and sticky. Moreover, German ores of the Kahlenberg type and similar ones are put through.

These different ores are fed to the furnace separately, i. e. the sorts are put through according to requirement and may change several times a day.

Special attention had, therefore, to be given to a suitable fit of the passage points between the machines and aggregates, as hard and sticky ores had to be put through alternately. Furthermore, the different bulk densities of the various sorts of ore caused an alteration of the discharge parabolas of the belt conveyors.

Thus extensive screening tests with the different sorts of ore were to be made, before the passage points were given the final fit.

The crushing and screening plant, built up by us for Messrs. Phoenix—Rheinrohr AG., Duisburg-Ruhrort, may be charged either from ore stockpiles in the harbour or a waggons unloading yard. In this case, the waggons are laterally discharged into ground storage bins, under which apron feeders are arranged with adjustable conveying speed. The material is then fed onto inclined belt conveyors having a width of 1200 mm. The latter feed to the primary screens of the crushing plant.

The plant is divided into two systems with a maximum capacity of 500 t/h each.

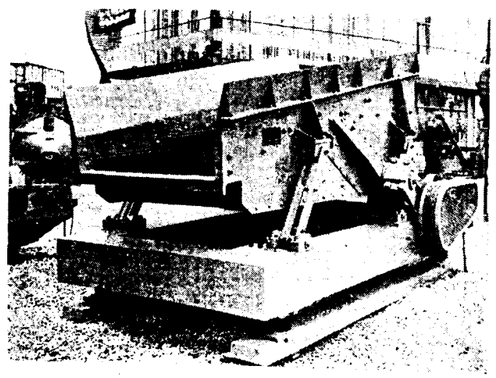


Fig. 1. WEDAG's Shaking Screens with Step Grates

The fed ores with a maximum size of 400 mm are first classified on horizontal counterbalanced action shaking screens of inclined arrangement with step grates—fig. 1—into fractions +70 and 70—0 mm. The lump material +70 mm comes to cone crushers with a feed opening of 1725 mm—fig. 2—and is pre-crushed here down to —70 mm. The crushed material and the screenings are then reunited on one inclined belt conveyor each and delivered to the secondary crushing plant. After preceding screening into fractions +25 and 25—0 mm, secondary reduction is effected down to —25 mm. For this secondary reduction, roll crushers—fig. 3 — and roll mills are provided for. These crushers work at a rotational speed of 6—8 m/sec. Also in this case the screenings and the crushed material is reunited on inclined belt conveyors feeding onto the screening plant.

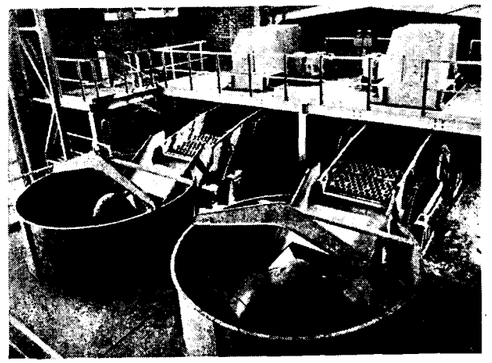


Fig. 2. WEDAG's Cone Crushers

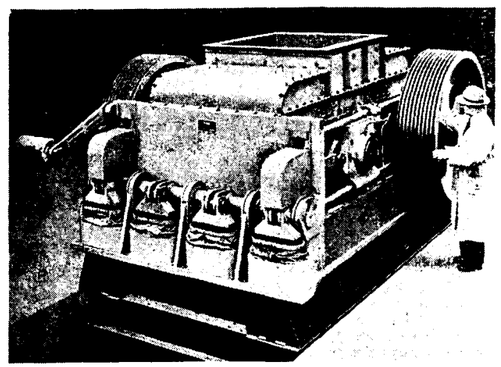


Fig. 3. WEDAG's Roll Crushers

For the fine screening, horizontal counterbalanced action shaking screens as well as resonance vibrating screens may be used.

In this plant, horizontal counterbalanced action shaking screens have been used to obtain fractions of 25—8 and 8—0 mm.

The latter fractions are then separately directed via inclined conveying systems to a compensating bin comprising 6 cells with a capacity of 700 t each. According to requirement, the single fractions are then delivered into the bins arranged before the furnaces and the sintering plant.

To keep the whole plant free of dust, a dedusting installation—fig. 4—is provided for. Hose type suction filters, design WEDAG-FISCHER, are used here working with an effect of 99.9%. The special advantages of these filters are : intensive shaking, good cleaning, and tight stretching of the bags ; each bag is flexibly-suspended and therefore has a longer lifetime.

The machines and aggregates are individually driven by means of reduction gear units or V-belts.

In the above crushing and screening plant 1,685 HP are installed.

A 2-system crushing and screening plant for a metallurgical work has been described above with a capacity of 500 t/h per system, where approx. 25 different sorts of ore are pre-treated for feed onto the furnaces and the sintering plant.

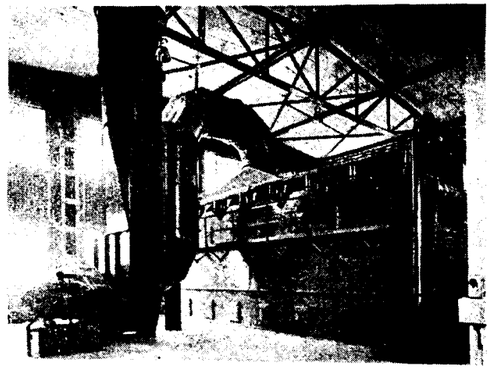


Fig. 4. WEDAG's Dedusting Installation

(Continued on page 8)

SPACE-SAVERS TO INDUSTRY

By A Special Engineering Correspondent

SAVINGS BY INDUSTRIAL TRUCKS

THE industrial truck, in the last decade, has received world-wide recognition as the most effective weapon in the constant battle to reduce manufacturing costs and increase output in industry.

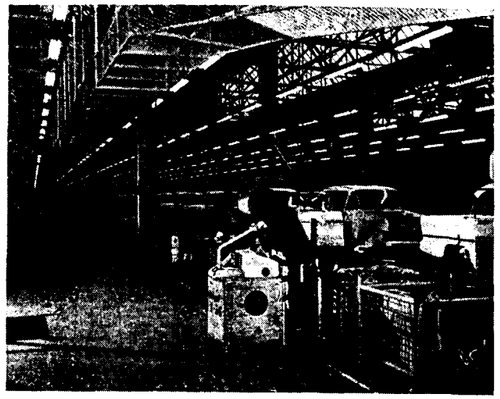
Even in the most thickly populated areas of the world, manpower has become expensive to hire and the proper use of industrial trucks will save not only labour costs but what is equally important, time and space. More than anything, it is this factor of space with which the well-known firm of truck manufacturers, Lansing Bagnall Ltd. of Basingstoke, England, has concerned itself and their very extensive range of electric powered vehicles are to be found all over the world operating in situations where it was formerly considered impossible to use mechanical handling methods.

CANTILEVER FORK TRUCKS

The modern conception of a lift truck is a machine capable of picking up a load which may be placed on some form of platform or pallet, or which may be formed into a bonded pack to be handled by special devices fitted to the lift truck. The cantilever fork lift truck carries its load forward of the front wheels of the machine and relies on the counter-balance effect of the rear wheel loading to maintain stability.

The uses to which fork lift trucks may be put are infinite, and often, operators who have originally purchased a machine for a specific purpose find a hundred and one other jobs for it after a very short time.

Fork trucks are built in an extensive range of sizes, shapes and types. They may be designed to pick up a load of as little as 1000 lbs. or as large as 50 tons. They may be powered by various means including petrol, diesel, L. P. Gas, and electric battery. They can be driven by a pedestrian, an operator standing on the truck or seated.



Speedy movement of goods is essential in the car industry to keep the track moving and here the Transloader model PPR 45 is shown distributing box pallet loads of stores to their station.

The trucks most common throughout world industry today are those with a capacity of between 1 to 2 tons. Among the trucks of this size in the Lansing Bagnall range are a pedestrian operated truck of 1 ton capacity and various types of rider operated cantilever

(Continued from page 7)

Besides the before-mentioned plant, WEDAG have delivered a similar plant for Messrs. Societe Metallurgique Esperance—Longdoz S. A., Liege/ Belgium, which is in operation for some months already. In its final arrangement, this plant shall have a capacity of 1400 t/h. One system with a capacity of 700 t/h is already working now.

Mainly Minette ores are treated here, the feed material containing lumps with maximum edge lengths of up to 600 mm ; final reduction to —35 mm and separation into fractions 35/15, 15/8, and 8/0 mm.

Both plants represent a new experience of pre-treatment of different sorts of ore for furnaces and sintering plants, and are working satisfactorily. As a result WEDAG have received further inquiries from Germany and abroad, which are now under work.

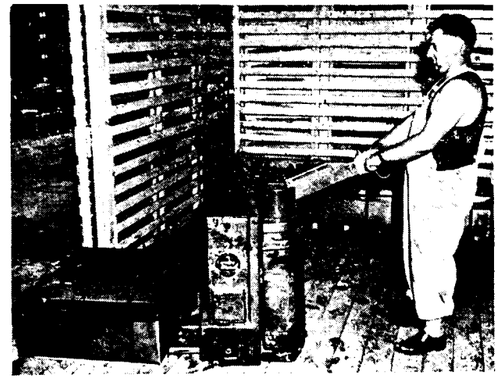
trucks, the most modern of which is a revolutionary machine which lives up to its name, Rapide. This fork truck is unique in the electric truck field inasmuch as it is capable of travelling at speeds hitherto considered impossible for electric powered vehicles. In the past, one of the big factors affecting the choice of power for a lift truck has been the speed of operation which has always favoured internal combustion engines. One the other hand, trucks powered by internal combustion engines have their drawbacks, not the least being the problem of toxic fumes which are given off by exhausts. Fumes are not a serious disadvantage in open areas or even in large well ventilated buildings, but there are many industrial applications where such fumes are not permitted. In these circumstances, the Rapide has answered the purpose by providing a fume-free operation, yet at the same time working at speeds equal to and often faster than many internal combustion engined machines.

The cantilever fork truck may be considered the ' maid-of-all-work ' of the industrial truck family, and performs countless tasks. It also plays an important part in any factory where space is at a premium. The ease with which loads can be lifted to ceiling height and accurately stacked allows what was formerly unusable spcce to be filled with goods.

Often, a building which was formerly used to store goods at floor level only, because of difficulties in raising loads by manual methods, has been reorganised by the use of lift trucks, and three times as much volume of storage provided. Such schemes have made the building of additional warehouses and and stores unnecessary and the consequent saving both in labour and building costs have more than paid for the installation of the industrial truck equipment.

SPACE-SAVER EXTRAORDINARY

Useful though the coventional fork truck is in saving space, users, once they became attuned to the possibilities of the unit load system looked for additional gains in storage volume. The counter-balance fork truck does, of necessity, require a fairly large minimum working gangway from which to be able to stack unit loads. It was felt that a machine capable of working in a much smaller gangway would be an asset despite the obvious disadvantage that narrow gangway working would slow down operational speeds.



The Transloader model POEP 2 is ideal for operating in confined spaces. A special version designed for handling packs of tinplate is seen here being used to unload railway waggons.

Model FRES 2 Spacemaker 1-ton Reach Truck is shown here stacking box pallets in a very narrow gangway. 6 ft. is all that is required to enable the operator to stack 40" square pallets to heights of up to 16 ft.

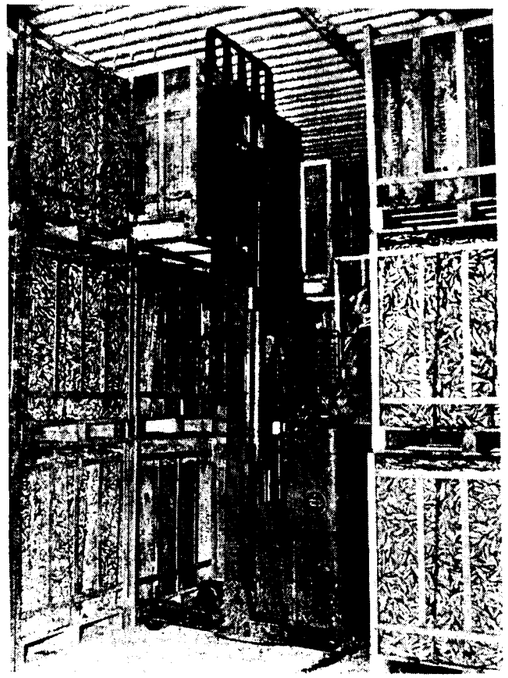
Various ideas were tried and new trucks designed, but one type, which originated in America, ultimately proved superior. The reach fork lift truck, a name descriptive of its operation, has not yet received the same amount of attention in the U. S. A. as it has in the U. K. and the Continent of Europe where it has proved immensely popular over the last few years. As early as 1952 Lansing Bagnall foresaw the possibilities of this machine and pioneered its introduction into British industry. Since then, they have become one of the acknowledged leaders of reach truck design and now build a wide range of models of this type.

The reach truck differs from the counter-balance fork lift truck in the positioning of the load during travel. Instead of the mast and fork carriage being fixed in front of the wheels, the whole assembly can be advanced or retracted. When picking up or placing loads, the mast and forks are " reached " out, in front of the wheels, and the truck functions as a counter-balance fork truck. After the load has been picked up, or set down, the whole mast assembly is retracted. With an average size of lcad, its centre of gravity lies behind the front wheels within the wheel base.

This ability to shift the load centre to a point within the wheel base means that a heavily counter-weighted chassis is unnecessary, and good stability can be obtained with a much smaller and lighter body. Thus the truck is able to operate from a much smaller gangway.

The savings in space achieved with this type of truck are exceptional. When it is realised that a 1-ton capacity truck of conventional counterbalance type requires a gangway of at least 9 ft. in which to operate with a 40" square load, the ability of the Lansing Bagnall 1-ton reach truck model FRES 2 to stack the same load in a 6 ft. gangway becomes a noteworthy feat. In effect, the aisle thus reduced enables an extra area of pallets to be stored and in terms of volume, three or four times this amount can be gained.

There have been occasions when industrial concerns looking for extra space in order to expand their businesses have made plans for extensive new buildings. In many cases, they have consulted Lansing Bagnall about their handling problems before going ahead with their building plans and by reorganising their existing storage using reach trucks for handling, the erection of new buildings has become unnecessary.



Cold Store Operation.
Here the Spacemaker 1-ton Reach Truck model FRES 2 is seen operating in a refrigeration chamber staking pallet loads of frozen fish. This truck is capable of operating in temperatures down to -20°F

When the present day cost of a new building is considered, one can visualise the immense savings which the comparatively inexpensive reach truck can make.

HORIZONTAL TRANSPORT

Many fork lift trucks perform combined duties of stacking loads and transporting them from place to place. When distances are short and stacking duties are light, it is often more economical to use the truck in this way.

There are, however, applications where goods must be carried over long distances and where also the stacking duties may be appreciable. In such circumstances it is often more economical to restrict the use of the fork truck to stacking duties only and to operate a less expensive form of truck for transporting the goods.

Trucks used for horizontal transport are basically of two types, one being the industrial tractor which does not carry loads but tows a train of trailers, and the other being a load carrying truck, either on a platform or on forks.

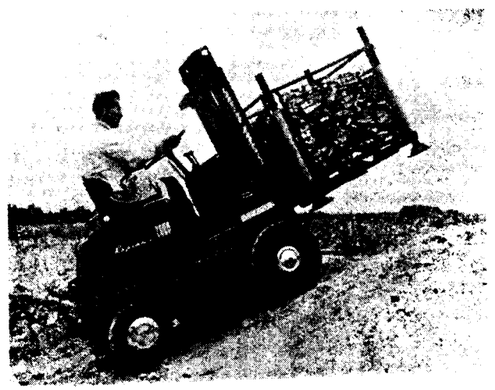
TRACTOR/TRAILER

The industrial tractor by no means resembles its agricultural brother. It is usually designed specifically for the purpose and as it is used very often in confined spaces, offers more protection to the driver and is much more compact than the normal agricultural tractor. As with fork trucks the industrial tractor may be powered by various means and ranges in capacity from the small electric powered tractor designed to tow loads of not more than 5 tons, to large petrol or diesel engined machines capable of pulling huge passenger aircraft at considerable speeds.

A normal tractor/trailer system often uses an electric or diesel powered tractor capable of towing trailers totalling 10/20 tons. The TODR 2 or TOER 2 tractors made by Lansing Bagnall fall in this category and are often used for regular services around an industrial plant.

LOW LIFT TRANSPORTER TRUCKS

Tractor/trailer trains require room to manoeuvre and are, therefore, often confined to outdoor applications or indoors in areas free from machinery or personnel. In congested areas, the ideal companion to the fork lift truck is the pallet or stillage transporter.



This electric truck, the Rapide 2000, has been designed to operate on all sorts of surfaces. It can climb steep gradients at speed and yet is manœuvrable enough to be able to work in confined buildings. With its exceptionally high travel speed the Rapide is a true all-purpose machine.

Electric trucks of this type are capable of lifting pallet or stillage loads from the ground under their own power and transporting them between stacking stations. A small pallet transporter of the Lansing Bagnall model POEP 2 type, is invaluable for handling goods between warehouse and transport vehicles. This truck, which is so compact that it extends the load length by only 18" can handle pallets with loads of up to 2 tons in confined spaces like railway waggons and transport lorries. Its overall weight is light enough to enable it to go into elevators so that goods can be carried from one floor of a building to another.

The forks are raised hydraulically and have a lift of 6", which is sufficient to raise most pallets or stillages off the floor so that the truck can travel with them. A truck of this type is easily capable of handling a load of 40" square in an aisle of 6 ft. Thus the POEP 2 can prove an ideal partner to the FRES 2 reach truck, allowing the more expensive high lift truck to carry out stacking duties exclusively, whilst transporting is performed by a much cheaper pallet transporter.

THE FUTURE

We have described, so far, a very small but important part of the large industrial truck family. There are trucks which carry their loads underneath, at the side, as well as behind or in front. There are machines built specially for the timber industry, for the steel industry and numerous other specialist trades.

Nor have we mentioned the very extensive field of hydraulic attachments which are used with all types and sizes of lift trucks. Such attachments do away with the need for handling loads on platforms or pallets and help to speed handling as well as saving the cost.

The trend in mechanical handling circles at present is an ever-increasing movement towards the use of off-the-floor handling equipment. The cost of bulidings is already prohibitive and any savings which can be made by the introduction of handling methods which do not require heavy and expensive fixtures are all to the good.

(Continued on page 12)

FLOTTMANN constructing double-acting short-stroke Compressors

By A Special Correspondent

SHORT-stroke compressors have a small stroke in proportion to the bore. Often the stroke is minor than half of the cylinder diameter of the 1st stage. This design, in contrary to the long-stroke compressors, has two decisive advantages, and that :

(1) An increasement of speed is possible at the same piston speed of the long-stroke compressor. This is a very important fact considering the life of the machine.

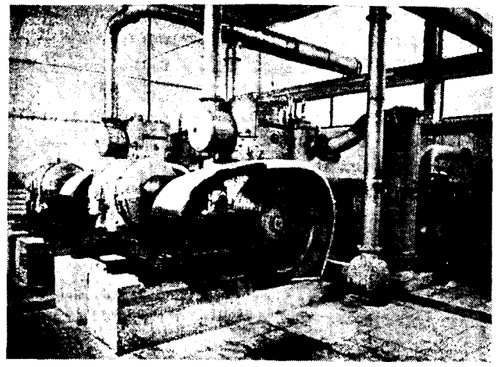
(2) By means of larger valve sections the valve resistance and the power consumption of the compressor are reduced.

Our compressor-types ME and MJ now take the place of the horizontal long-stroke plants for they share with them the advantage of a long life without having their disadvantages. For our new compressors are constructed in the angle-arrangement the considerable mass forces of the first degree, peculiar to the horizontal design of the type MG, are abolished. The space requirement for erection diminishes by more than the half and so a quiet and vibrationless running is guaranteed.

ME-compressors are two-stage and constructed for the free air delivery of 450 up to 3300 m3/h. Their final working pressure is 10 atu (142 p. s. i. g.), even higher in case of special constructions.

MJ-compressors are single-stage with working pressures up to 3 atu (42,6 p. s. i. g.).

Our new series ME and MJ extend over a free air delivery from 450 up to 6600 m3/h per unit.



FLOTTMANN Compressor " MJ·600 "

OUR TWO-STAGE TYPES

ME 100, ME 130, ME 170 ME 300, ME 600

OUR SINGLE-STAGE TYPES

MJ 100, MJ 130, MJ 170, MJ 260, MJ 340, MJ 600, MJ 1200

(Please note : the number before the last zero always indicates the *free air delivery in m3/min*)

Besides these series we also supply Boosters and Rotary Compressors in similar designs, for pressure

(Continued from page 11)

Overhead gear formerly considered essential in many industries is being ousted by trucks working from the floor. Heavy crane runways and overhead gantries or conveyors which do not permit future relocation prevent the natural growth and expansion of industries. Buildings have to be made stronger in order to support the heavy loadings and stresses imposed by this type of equipment. All these drawbacks can be overcome by the use of off-the-floor handling machines and the constant research and desire for improvement which goes on in the industrial truck manufacturing industry will ensure that the gains it has already made will be continually increasing.

ratios from 1 : 1 up to 1 : 3, at final pressures up to 10 atu (142 p. s. i. g.). Free air delivery and power requirement differ according to the ratio of compression and the desired final pressure.

Owing to their specific low power consumption ME-compressors mostly operate as main machines in Aircraft. Centres at working pressures of about 7 atu (99,4 p. s. i. g.), whereas our types MJ are used at sites requiring only minor pressures (up to 3 atu—42,6 p. s. i. g.), as per example :

for the production of vital breathing air, when constructing river-syphons,
for pneumatic transport of liquids (sulphuric acid etc.) in the Chemical Industry,
for Cement—Textile—and other industrial lines of economy.

The new ME— and MJ-series are appropriated for continuous as well as for intermittent operation.

Two-stage compressors with capacities of up to 1000 m3/h and single-stage units with capacities of up to 2000 m3/h can be erected on foundation frames standing on rubber feet. In case of this construction additional mounting works at site are not necessary. The only installation works are the connection of the pressure—the cooling-water-pipes and the electric cable. The compressor so connected within the shortest delay runs without vibrations to the surroundings.

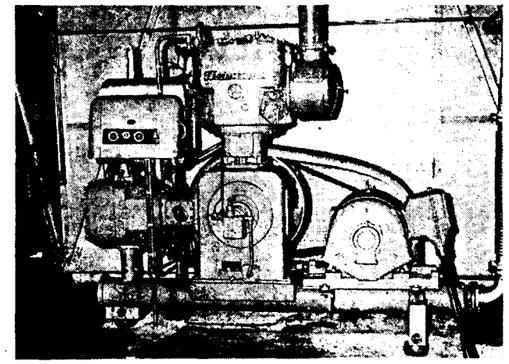
The tube-shape foundation frame simultaneously is supplied with an after-cooler insertion.

The following expositions will give you an informative idea of the numerous possibilities of use of our ME—and MJ-short-stroke compressors in the practice of many industries.

TUNNELING

At the end of the year 1959 the first phase of construction of a 50-million-project—super clarifying plant Dusseldorf—has been finished. In order to carry off the waste water from the left side of the Rhine to the right one the Rhine had to be tunneled and that for a length of approx. 1000 m at a height of the tunnel of 3,80 m. In co-operation of American and German engineers the tunnel was driven-on by means of the " Caisson " a steel tube of 5 m of length and a diameter of 4 m. In the " Caisson " and in the tunnel permanently a counter-

(Continued on page 14)



FLOTTMANN Compressor " ME " working in a Western German Works.

pressure had to be produced by compressed air, in order to face the water column pressure and to prevent the slipping-down of the shifting sand. In order to preclude the " Caisson disease " the staff was sluiced in and out in pressure sluices. During the entire construction period the tunnel was furnished with approx. 25 million m3 of compressed air, delivered by FLOTTMANN short-stroke units of the series MJ. Owing to the undisturbed operation the time of construction could be diminished by 2 months. This extraordinary construction project interests the experts in our own country and also in the foreign countries.

A large *Fitting works* in Southern Germany employing a staff of approx. 5000 men, intended to build a new Aircraft Station in 1961. After careful deliberations FLOTTMANN short-stroke compressors ME 170 have been provided for the equipment of the Centre. Our photo shows the unit in the new workshop hall.

A factory with a staff of 1000 men in Western Germany, producing daily 1000 *refrigerators* as well as additionally *exhaust boxes, oil-heating devices, fuel tanks, instruments for the radio industry etc.*, and therefore needing a continuous kind of operation, has given preference exclusively to FLOTTMANN air-compressors, particularly to the space-saving types ME.

Also in a *Hammer Mill* the compressed air of our ME-short-stroke plants supplies the power to the heavy duty hammers, by means of which big moulded pieces are worked.

Lang Pneumatic's New Types of Cylinders & Valves

CYLINDERS

CONSTRUCTED mainly of non-ferrous materials and stainless steel, the Lang Pneumatic cylinder range provides a cylinder to meet most requirements.

Double acting and single acting cylinders are supplied in a wide variety of bore sizes and mountings.

Special cylinders can be manufactured at customers request and bore sizes of 20" diameter and strokes of 18 ft. have been supplied.

Lang Pneumatic Double Impulse Cylinders are in effect two double-acting cylinders arranged back to back and having separate piston rods. It is possible to obtain, therefore, two distinct and positive movements from one unit.

Lang Pneumatic Basic Cylinders, built from ex-stock items, are available in a number of bore sizes, strokes and mountings, giving a variety of over 300 cylinders available " off the shelf."

With some cylinder applications it is advisable to cushion the end of the stroke in order to absorb the inertia of the moving parts and so eliminate any harmful shock. Lang Pneumatic Cushioned Cylinders can be supplied in any of the standard bores and mountings, and with cushioning at either end or at both.

Air Hoists which speed handling operations in a swift and smooth manner, are available in six bore sizes from $2\frac{1}{4}$" to 8". Special overhead trolleys and mountings can be supplied to requirements.

When oil dashpot control is required for an air cylinder movement, the Lang Pneumatic Hydro-Pneumatic Unit provides the neatest and most satisfactory answer, provided space limitation does not prohibit the increase in overall length.

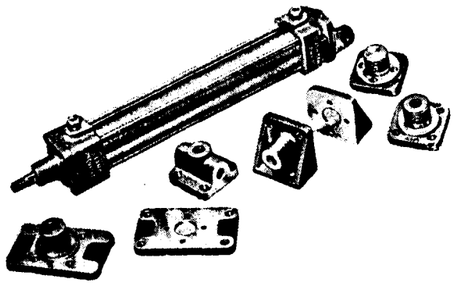


Fig. 2. Typical Lang Pneumatic Basic Cylinder with alternative mountings.

They are available in $1\frac{1}{2}$" to 8" bore sizes and seven different mountings.

Lang Pneumatic Reciprocating Cylinders are available with most forms of mountings and in a wide range of bores and strokes. Can be supplied in a totally enclosed form. A typical example of the variable speed of this type of cylinder is for a $\frac{3}{4}$" stroke cylinder, maximum oscillation of 65 strokes per minute and minimum oscillation of 5 strokes per minute.

Two further types are available one of which has a pilot valve built in each end cover and an auto-valve built in the rear cover. The other type has a pilot valve built in each end cover, but has its auto-valve attached to the outside of the cylinder barrel. This latter enables the auto-valve to be readily detached from the cylinder and placed wherever convenient, and it also allows the operating speed of the piston rod to be considerably increased.

Cylinders with Built in Pilot Valves are also available in a wide range of bores and strokes, and with most forms of mountings. They can be supplied with one pilot valve only, if required.

Lang Pneumatic Duplex Cylinders are two double-acting cylinders arranged on a common piston rod. It is therefore possible to obtain a number of different movements from one unit. They can be supplied with uneven strokes.

A large range of pneumatic valves, cylinders and accessories is manufactured by Lang Pneumatic Limited sufficient to meet most requirements.

VALVES

The main materials from which our valves are manufactured are non-ferrous and stainless steel.

(Continued from page 13)

We only name a few examples, the number of which could be enlarged of choice.

The FLOTTMANN-WERKE, who, unceasingly intent on progress, developed to one of the leading German Firms in the line of technique of compressed air, now are existing for 90 years.

FLOTTMANN products have a world-wide renown.

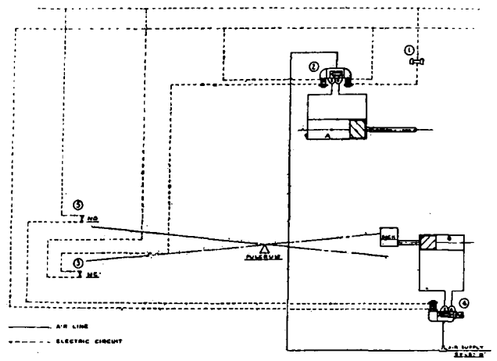


Fig. 3.

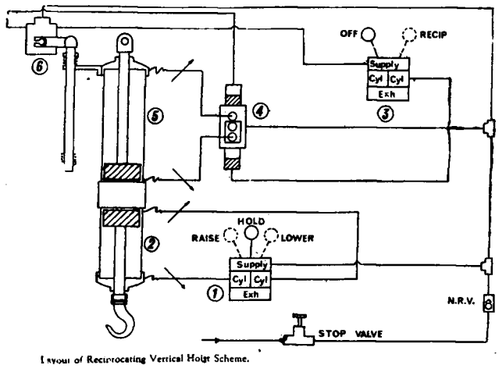


Fig. 4.

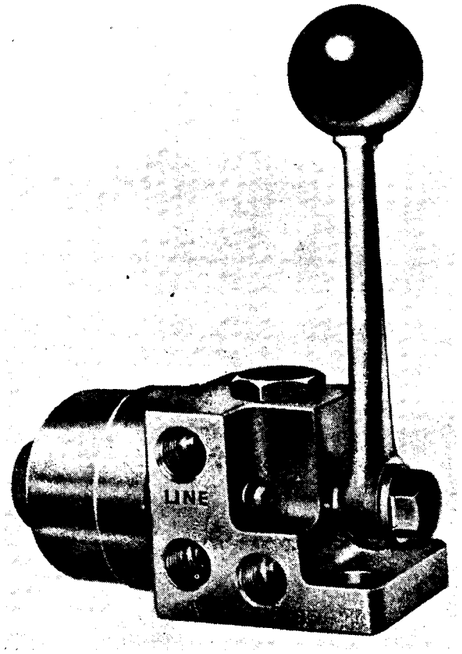


Fig. 1. Hand Control Valves

A basic valve of the rotary slide valve type (illustrated here as Hand Control Valve, fig 1.) forms the basis of part of our Valve range. It can be supplied in a large variety of adaptations such as, foot operated, automatic or with integral locking piston, etc.

A further group of valves operate on a linear slide valve principle. The basic valve of this range can be adapted for either air or solenoid operation or a combination of both; or the valve can be arranged for self-reversing.

A range of manifold mounted valves is available with alternative manifold for side port entry. These allow for removal of valves for servicing, etc., without disturbing pipeline connections.

Lang Pneumatic Solenoid Valves have been designed to perform any high speed control duty initiated from an electrical source. They will operate on A. C., 12 to 440 volts, 50 cycles; and on D. C., 12 to 250 volts. They are just as economical with current as more conventional valves are with air. A

large number of the air-operated automatic valves are available with solenoid operation.

Diaphragm Valves are necessary in systems in which the valves and cylinders cannot be operated by small signals from instrument lines with pressures from 3—15 p. s. i. The diaphragm valves will respond to low pressure signals and thus servo operate high pressure equipment.

A great many circuit refinements can be introduced with these valves.

Lang Pneumatic Rotary Valves have a multiplicity of ports, the only practicable factor governing the number is the size of the valve housing. Each port is opened in sequence, either automatically, by an air signal or by hand, and cylinders, valves, etc., in various locations are operated as desired. Amongst those we can supply are a 5 port hand control valve, a 6 port valve with keyed spindle and an air signal operated valve which is available with either 8,10 or 12 ports.

Lang Pneumatic Pilot Valves are small and neat in appearance, robust of construction and are extremely efficient and reliable. They combine small operative movement with sensitivity of action. Various adaptations of the basic pilot valve are available allowing different methods of operation.

Micro pilot and double air operated pilot valves are also available.

FITTINGS

If you want your air supply regulated, filtered and lubricated to ensure a longer and more efficient life for your equipment, we can supply the necessary accessories. We also produce a comprehensive range of pipeline fittings and adaptors. Additional items which are available are silencers, non-return valves, pressure gauges, gaiters, etc.

SACK FILL & DISCHARGE SCHEME

The operation is as follows (see layout).

When push button (1) is depressed solenoid valve (2) is energised which retracts cylinder (A) in turn operating slide and allowing the sack to be fiilled, when the sack is full a counter balance arm releases a normally closed micro-switch (3) which energises solenoid valve (2) thus reversing the air flow extending cylinder (A) and cutting off flow supply to the sack.

The counter balance arm closes micro switch (5) energising solenoid valve (4), which retracts cylinder (B) tipping the sack from the cradle. When the sack has been discharged the counter balance arm swings back to its original position, thus opening micro-switch (5) and allowing valve (4) to reverse, thus extending cylinder (B) and bringing the cradle back to the operating position. Micro-switch (3) is then operated, which breaks the supply to solenoid valve (2) thus completing the sequence.

VERTICAL HOIST SCHEME WITH RECIPROCATING MECHANISM

A hoist type control valve is arranged to raise, lower or arrest unit (2) of the Double Impulse Cylinder, and when the lever of Valve (3) is moved to the "reciprocate" position Automatic Valve (4) will be reversed, and unit (5) of the Double Impulse Cylinder will be lowered. At the end of the stroke Impulse Valve (6) will be tripped to reverse Valve (4) thus unit (5) will be raised.

This reciprocating movement will continue until such time as the lever valve (3) is moved to the "off" position, thus cutting off the signal from Valve (6) to one side of Automatic Valve (4), consequently the oscillating movement will always be arrested with the Cylinder in the raised position.

Copper-Alloy Tubes for Condensers in Sea-going Vessels

The Indian Standards Institution has prepared a draft Indian Standard Specification for Copper-Alloy Tubes for Condensers in Sea-Going Vessels. This draft standard specifies the requirements for copper-alloy tubes for condensers used in the manufacture of equipment for sea-going vessels, or in situations where hard water is to be used in the condensers. It covers tubes of outside diameters 10 mm to 40 mm inclusive. The draft standard will be put into wide circulation by the end of February 1962 for a period of three months to interested producers, consumers and technologists for eliciting technical comments, which will be taken into consideration before finalizing the draft as an Indian Standard.

Developments in engineering applications of rubber

By A. N. GENT, P. B. LINDLEY and L. MULLINS
"Natural Rubber Bureau's Research" Dept.

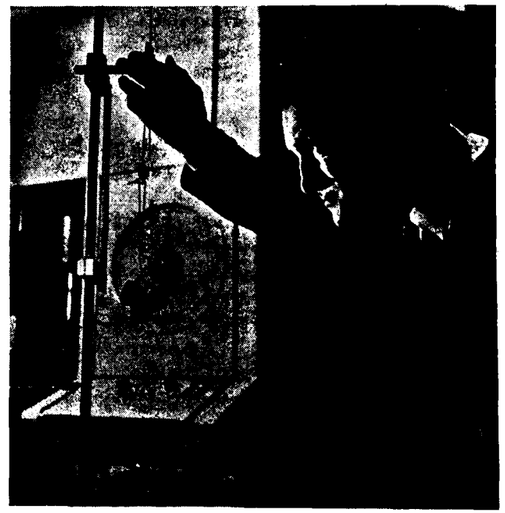
THERE is a general difficulty experienced in designing rubber components, due either to the absence of necessary basic information or to its non-availability in a suitable form. Recent studies which have gone some way towards remedying these deficiencies are discussed. They show how the stiffness of rubber components depend on their shape, size, temperature, mode of deformation and on the nature of the rubber compound. They also provide an understanding of the sources of failure likely to occur in service and of methods of preventing premature failure. With this information, it is now possible to undertake the basic design of rubber components for a wide range of engineering applications without recourse to a completely empirical approach. Recent and novel uses of rubber in civil engineering involving the application of this knowledge are described. These involve its use in bridge bearings and rail fastenings.

Rubber has long been established as an important material for use in engineering applications. Indeed, there are few materials with such diverse uses, reflecting so wide a range of mechanical properties. There is still a general difficulty in designing rubber components, however, and this seriously restricts its further acceptance and development as an engineering material. The difficulty arises from a lack of appreciation and understanding of the characteristic qualities of rubber, and also from the absence or inaccessibility of the basic information necessary for design calculations.

These deficiencies stem from two distinct sources. The first appears to be associated with differences in the training of rubber technologists and design engineers, who often have different approaches to common problems. The second reflects ignorance of the basic principles governing the behaviour and life of rubber components in service, and necessitates the development of a fuller and sounder knowledge of these properties. Attempts have been made to overcome these difficulties, and there is now evidence of an expanding use of rubber in engineering applications in which it is used more correctly, and to better advantage than hitherto.

BASIS FOR DESIGN

In a successful design, the size and shape of a component and the type of compound to be employed are specified in such a way that (i) the component will perform its task adequately; (ii) it will be reliable; *i.e.* sufficiently long-lived; and (iii) it will be as small, as light, and as cheap as possible. To achieve this, it is necessary to know how the stiffness and fatigue life of components depend on their shape, size, operating temperature, mode and extent of deformation and on the nature of the rubber compound employed. With this in view, work in our laboratories has for some years been directed to the solution of two problems; (i) how, and to what degree, a rubber unit will be deformed when certain forces are imposed on it, and (ii) how long the rubber will last in service. Initially, it was necessary to discover the fundamental basis for the elastic behaviour and the failure processes shown by rubber, since these would then provide the foundations for the solution of problems of direct practical interest.



Simple tensile tests, such as this, on rubber strips provide information used in the design of rubber springs for mechanical and civil engineering applications where loads of hundreds of tons may be encountered. The final product is tested on the large Denison machine in the background.

ELASTIC BEHAVIOUR

The classical theory of elasticity, which is the basis of standard engineering practice, only applies to materials in which the strains are very small (less than a few per cent.). A theory of rubber-like elasticity must be concerned with much larger strains (up to several hundred per cent.), and it is only recently that a comprehensive mathematical treatment has been developed for large elastic deformations (Rivlin, 1956), *i.e.* for rubber-like behaviour. The theory only applies strictly to ideal rubbers, which are completely reversible, incompressible and isotropic, but in practice extensive experimental checks of the predictions of the theory show that actual rubber conform quite well (Rivlin and Saunders, 1951).

The behaviour of certain components may therefore be calculated for deformations of any practicable amount. For example, exact calculations can be made for large deformations in simple extension, compression and shear ; in the torsion and simultaneous extension of cylinders, tubes and prisms, and in the flexure of thick sheets and deformation of sheets reinforced with cords. This represents a major advance.

However, when the deformation is complex, an exact solution may be unattainable. In these cases, approximate relations based on small-strain theory must suffice. Satisfactory solutions have been derived in this way for two complex but particularly important components, bonded rubber sleeves (bush mountings) (Adkins and Gent, 1954) and bonded rubber blocks (Gent, 1958a ; Gent and Lindley, 1959). The latter are probably the most widely-used engineering components. Because of their great practical importance the load-deformation relationships are given below.

The shear stiffness Ss is given by

$$Ss = AG/h$$

where A and h are the cross-sectional area and thickness of the block, and G is the shear modulus of the rubber. With thick blocks, a correction has to be made to allow for the flexural contribution to the deflection, but this is relatively small when the thickness is less than the width of the bonded surface (Rivlin and Saunders, 1949).

The compressive stiffness Sc is given by

$$Sc = AE(1+kA/2\pi h^2)/h$$

for blocks of circular section, and

$$Sc = AE(1+kA/8h^2)/h$$

for blocks of square section, where E is Young's modulus for the rubber and k is a constant, taking the theoretical value of unity for soft, highly-elastic rubbers and a somewhat smaller value for harder, less perfectly elastic rubbers (Gent and Lindley, 1959).

In design calculations employing relations of the kind discussed above, it is clearly necessary to know the value of the elastic modulus for the rubber compound. The shear or rigidity modulus is most widely used because many units employ rubber in shear or torsion and because load deformation relationships in shear are linear up to relatively large strains. The modulus depends on the nature of the rubber compound and may vary from 40 to 400 lb./sq. in. Young's modulus varies similarly from 120 to 1,500 lb./sq. in., but this applies only to small extensions and compressions as the load deformation relationships are non-linear for large strains. A formula relating Young's modulus to the British Standard hardness of the vulcanized rubber has been derived theoretically it permits the preliminary design of units from hardness measurements alone (Gent, 1958b).

FATIGUE FAILURE

From a detailed study of failure processes, including tearing and cut growth, a new understanding of fatigue failure has been gained (Thomas). It now appears that fatigue consists of the growth by repeated tearing of micro-scopic flaws or defects in the rubber, generally in the surface. The flaws are initially very small ;indeed, they only reach a visible size in the last stages of the fatigue process, and hence their role has hitherto been unsuspected. Failure occurs when the flaws have grown into large cracks, so that the stiffness or strength of the component is seriously impaired and it becomes unserviceable. This state is attained gradually, however, in marked contrast to the sudden catastrophic failure of metals, for example, and constitutes an important and valuable advantage of rubber springs.

Simple expressions have been derived to describe the growth of these flaws under repeated tensile strain (Thomas). For natural rubber, the fatigue life, or the total number of strain cycles before failure, N, is given by

$$N = G/(4W)^2c$$

where G is a constant which characterises the resistance to cut growth of the rubber, W is the elastic strain energy applied per unit volume during each strain cycle and c is the initial size of the flaw. This relationship has been shown to describe the behaviour of a wide range of gum and filled compounds. Changes in temperature and frequency have little effect on the fatigue life of natural rubber, which is only seriously affected by changes in W, the maximum elastic strain energy, and c, the magnitude of surface defects, in accordance with the above relationship.

FATIGUE LIFE OF NATURAL RUBBER
(B.S. Hardness 40° to 60°)

Deformation	No. of cycles to failure*
0—50% extn.	1×10^6
0—100% „	1×10^5
0—200% „	1.5×10^4
0—300% „	2×10^3
0—100% shear	1×10^6
100—200% extn.	4×10^7

*Cadwell, Merrill, Sloman and Yost (1940)
Gent and Lindley (Unpublished)

The table shows the effect of strain on the fatigue life of natural rubber samples ; the pronounced increase in the fatigue life when the rubber is not completely relaxed in each cycle should be noted (Caldwell, Merrill, Sloman and Yost, 1940).

With SBR a quite different relationship is found :

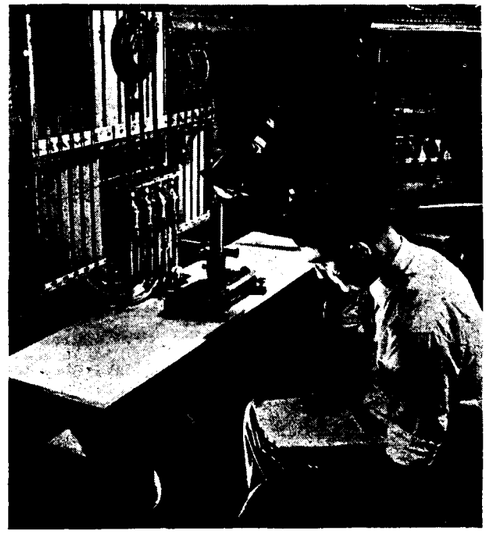
$$N = \tfrac{1}{3}\ G/(4W)^4c^3.$$

Here the fatigue life is more critically dependent on the size of the surface defect and on the severity of the deformation, *i.e.* the amount of the stored elastic energy, than with natural rubber. With low elastic strain energies and with rubber articles containing only minute imperfections or flaws, the growth of the latter is somewhat slower in SBR than in natural rubber, but as soon as the elastic strain energies or the flaws become large then the position of the rubbers is reversed. This latter rating (under more arduous conditions) is confirmed by practical experience. In engineering applications such as engine mountings or springs the fatigue life of natural rubber compounds exceeds that of SBR compounds by a factor of 10 or more.

The quantitative relationships which have been described above enable the fatigue life of rubber components to be calculated for a variety of simple deformation cycles. This represents a major development in the design of rubber components ; indeed a similar position has not yet been achieved with any other engineering material.

PRELIMINARY DESIGN CONSIDERATIONS

In the widely varying uses of rubber in engineering, such as in flexible mountings and couplings, in vehicle



The fatigue of rubber is a phenomenon most easily investigated by studying the growth of flaws in strips of rubber. In this experiment cut growth rates in the presence and absence of air are being compared.

suspension, in vibration insulation and shock absorption, the rubber component is used essentially as a spring. Estimates of the dimensions and performance of these components can often be deduced by the use of surprisingly few physical constants and equations.

The procedure is well illustrated by the following recent development of the use of rubber bearings in the mounting of bridges (Gent, 1959). In 1955, W. S. Atkins and Partners approached our Association for technical advice on the design of rubber bearings for bridges. In bridge construction the thermal expansion and contraction of bridge decks and the movements which occur under traffic and wind action are not generally imposed on the bridge supports, but instead on rocker or roller bearings or on sliding plates which allow the bridge to move freely in relation to its supports. However, these bearings and plates are

subject to wear and corrosion and require maintenance. The question posed was: could a rubber-to-metal bonded unit be designed to take the place of these systems? The units had to be made sufficiently soft horizontally to impose only minor loads on the supports and yet be sufficiently stiff vertically to prevent appreciable changes in height under changing load. Initial discussions concerned the Pelham Bridge in Lincoln, where each rubber unit was required to support a vertical load of up to 130 tons without deflecting vertically more than 1/4 in. Horizontally, to avoid overstressing the supporting pier, it was required to permit a displacement of up to 3/4 in. without transmitting a load of more than 10 tons. The ratio of the vertical to the horizontal stiffness required was thus about 50.

At that time, the calculation of the shape and size of such a mounting was generally carried out by means of empirical relations of limited value. A theoretical and experimental study of the deformation of bonded blocks was therefore undertaken, leading to the establishment of the simple relationships quoted earlier. They were found to apply to flat blocks of a wide range of thickness and varied shapes of cross-section. Accurate calculation of bearing dimensions was thus made possible.

The high ratio of vertical to horizontal stiffness required in the Pelham bearings was achieved by the use of thin bonded rubber blocks. Five of these blocks were bonded to steel plates and combined in sandwich form as a single unit, each block being 24 in. long, 16 in. wide and 3/4 in. high. The entire unit, manufactured by the Andre Rubber Company was then surrounded by a layer 1/4 in. thick to protect the metal interleaves from corrosion and to provide deformable bedding surfaces for both the bridge deck and pier. The composite bearing had the required overall shear stiffness of about 10 tons per inch and a compressive stiffness of about 1,000 tons per inch.

The Pelham Bridge was completed in 1958, and similar bearings have been adopted in the design of numerous other bridges.

Natural rubber bearings of this type suitably compounded to resist weathering and long-term oxidative attack can be confidently expected to function efficiently for several decades; they should be at least as efficient as conventional bearings and require less maintenance. This use of rubber appears to have considerable potential. Complex bearings can be replaced by simple rubber bearings, since the stiffness of the rubber unit in different, directions may be varied by the use of flat, inclined or domed plates, giving low stiffness in two directions, one direction, and in rotation only, respectively.

A flexing test in which samples are exposed for periods of up to six weeks and examined periodically to find out how additives affect the growth of cracks. The deformation of samples is similar to that experienced by a tyre sidewall and the test is useful for predicting the behaviour of additives in tyre sidewalls.

Another important new application is the use of rubber in devices for holding down rail tracks, and is resulting in a minor revolution in permanent-way design. Joints between rails are responsible for an undue proportion of the maintenance costs of the track and are recognised as a source of premature fatigue of rolling stock. It is now established that if the rail is sufficiently firmly held down so that thermal expansion is prevented, it is possible to reduce the number of gaps considerably and employ continuous rails of the order of a mile in length. To achieve this, the fastening device must hold the rail firmly to the sleeper, and it is advantageous to use heavy concrete sleepers in place of wooden ones. About ten years ago, French railway authorities developed a simple spring clip and rubber pad fastening arrangement (Levi, 1952) which permitted the use of concrete sleepers by cushioning the concrete surface against rail impacts and held the rail sufficiently firmly against thermal stresses to permit the use of long, welded rail lengths.

In this application the rubber pad and the spring clip had to be designed so that no separation of the rail and pad occurred during passage of a train. In operation the spring clip is very stiff for upward movement of the rail, while the pad only permits such limited downward movement of the rail as is necessary to cushion impact. This involved designing a pad of a shape that deformed easily under the holding-down load but then became very much stiffer as the deformation was increased. Pads with suitable load-deflection characteristics were obtained by means of a grooved cross-section, in which the grooves closed up during the deformation, leading to a considerable increase in stiffness. Additionally it is necessary that the natural frequency of the pad and clip should be much higher than that of the section of rail between adjacent sleepers, about 800 c.p.s., so that they respond to vibrations in the rail.

Many millions of pads are now in use in France and are giving completely satisfactory performance, no maintenance other than protection of bolt threads against corrosion being required. In the United Kingdom, satisfactory performance of a number of types of spring clips and rubber pads has been established over extended experimental trials, and a rapid expansion of their use can now be anticipated.

The use of rubber in bridge bearings and in rail fastening devices is typical of many applications where rubber components can replace complicated and costly mechanical devices. They have been described here because they illustrate the type of problem which has to be solved in the early stages of the design of new components. Although additional work is still required, a basic framework, which permits the design of new components using rational and well-established principles, has now been constructed. The importance of this development in promoting new applications of rubber is becoming increasingly evident.

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(COURTESY: "RUBBER DEVELOPMENTS")

High Voltage Circuit Breakers

The Indian Standards Institution just prepared a draft Indian Standard Specification for High Voltage Circuit Breakers. This draft covers the general and performance requirements of all types of circuit breakers between voltage range of 1 000 and 11 000 volts. In addition, it also covers the definitions of terms used in connection with circuit breakers. This draft also includes a number of features which were agreed to at the international level.

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

Design and Production considerations for thin wall formed containers

By J. R. Lynch and Earl Smith
Plastics Technical Service, The Dow Chemical Company, Midland, Michigan

(Exclusively for Journal of Industrial Engineering, Bombay - India)

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EARL R. SMITH of Dow Chemical International S. A. is a plastics customer service engineer for Europe, located at the company's plant in Rotterdam, The Netherlands. Smith holds a master's degree in mechanical engineering from the University of Illinois. He has been active in the development of polyolefin films, polystyrene packaging formulations, and light-stabilized polystyrenes at Dow.

As plastics continue to penetrate the single use container market, proper design and production of these items become increasingly important. This is especially true with thin wall thermoformed items if the item is to offer maximum quality utilizing the minimum amount of material. The intention of this paper is to discuss some of the significant factors involved in the design and production of thin wall containers for various applications.

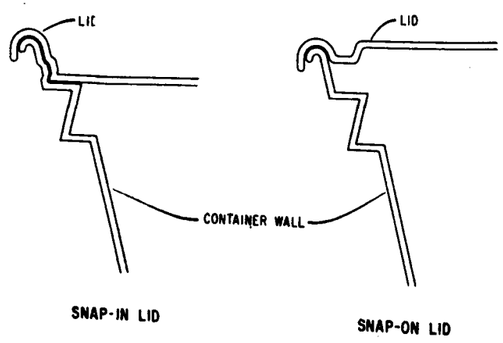
The information presented herein is based primarily on experience gained in working with high impact polystyrene, but the principles prevail regardless of the material used. High impact polystyrene was selected because it can be formed on short cycles with a minimum of difficulty over a broad temperature range. Further, it can be easily trimmed and is rigid enough to be self-supporting in thin sections and tough enough to provide good product protection

The technique and process advocated for fabricating most thin wall containers is plug-assist forming on a continuous machine. There are several reasons for this. First, plug-assist forming offers a fairly positive control over material distribution and the continuous machine is capable of the high production rates so necessary if plastics are to compete with some of the other materials now serving the single use markets. In addition, with plug-assist forming the parts are formed in a cavity mold and, on cooling, shrink away from the cavity walls making them easier to remove from the mold and more free of strains than parts formed on a positive mold. This lower strain level provides the parts with a higher working stress and makes them less susceptible to failure under severe service conditions. Also, cavities can generally be spaced closer together than positive molds increasing production efficiency. And lastly, a good polished mold tends to impart a fair amount of surface gloss to the item, giving it a higher quality appearance.

DESIGN CONSIDERATIONS

Plastics probably offer greater design freedom than any other engineering material for packaging because

TYPICAL LID DESIGNS



of their ability to be shaped and contoured at relatively low temperatures and pressures. The injection molding process undoubtedly offers the most opportunities in this area, but thermoforming is not far behind. The limiting factors in thermoforming, as compared to injection molding are (1) there is less control over section thickness, (2) less control of material distribution in that abrupt changes in wall thickness are not possible, (3) whatever appears on one surface appears as the negative on the opposite, and (4) the difficulty which exists in using breakaway section molds such as might be necessary for forming deep undercuts.

UNDERCUTS & ENGRAVING

It is possible to design and form containers having undercuts as deep as .025". However, when this is done, the upper portion of the undercut should have as much draft as possible to facilitate release. (These are the situations when it is helpful to be working in a cavity mold because of the shrinkage of the plastic may be utilized to facilitate release.) Usually, the only time it is necessary to have a relatively severe under cut in a mold is when a container is designed to use a snap-in closure ; these are generally no deeper than .020".

Normally, the only other place aside from the closure area where undercuts might be involved would be where engraving on the sidewall is required.

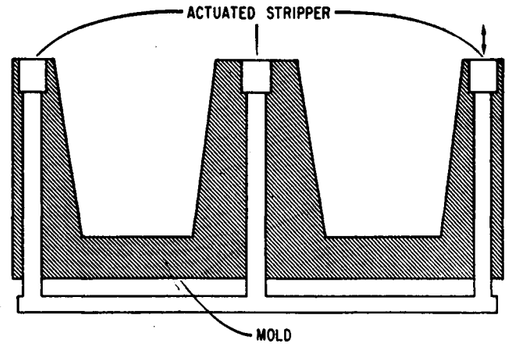
When the engraving involves a printed message, it has been found that letters should be no deeper than .010—.012" and if possible, should be tapered along the upper edges to facilitate release. Letters of this depth offer clear definition and present a minimum of release problems.

As the draft angle on the sidewall increases it may be possible to increase the depth of the engraving, but normally for wall tapers of about 10° or less it should be as stated above. The opposite also holds true, as the angle decreases the engraving should be made shallower. When a trademark or any other special identifying feature is engraved or embossed, the depth of the engraving in the center may be made greater and then gradually decreased toward the edges. Here too, however, the depth is contingent upon the sidewall taper.

STRIPPER DEVICES

It is advised that wherever undercuts are involved, the mold should be designed to incorporate a

EXAMPLE OF ONE TYPE OF STRIPPER DEVICE



mechanical ejector or other device to insure positive removal from the mold. Strippers for thermoforming molds can be designed in a number of ways, such as knockout plates located in the bottom of the mold or grids or stripper rings around the periphery of each cavity. Different types will be required for each application. Generally speaking, a stripper which pulls the parts from the mold will usually be more effective than one which pushes from the bottom, because in the latter case the warm plastic is likely to crush or distort. Under some conditions it might be advantageous to use both systems in a mold simultaneously. Regardless of the type of stripper used, its temperature should be kept as close as possible to that of the mold because if it is allowed to overheat, the forming machine may have to be slowed down or possibly stopped altogether.

There are two practical methods of controlling grid-type stripper temperatures. One is to make the stripper considerably deeper than it is wide so that it extends as far into the mold as possible and allows only sufficient clearance along the sidewalls to permit movement. The stripper bars (made of aluminum) would seat on a water cooled plate and be surrounded by the coolant circulating around the cavity walls. Under these conditions; sufficient heat should be dissipated between cycles to maintain the stripper temperature close to that of the mold. Another method of temperature controlling the stripper is to make it of rectangular aluminum extrusions welded together to form a grid and then circulate coolant through the system. The coolant should be introduced through a manifold to provide adequate circulation.

CLOSURES

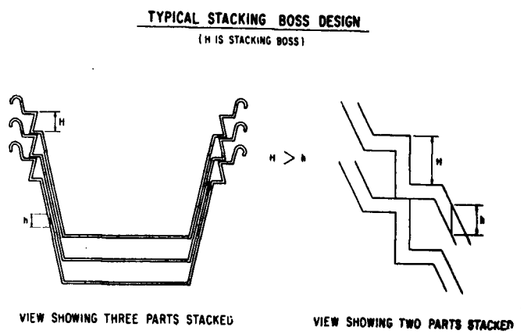
There are two types of closures or lids used on most formed containers—the snap-in type and the snap-over lid. Normally, the type of closure to be used will be determined by the product to be packaged. If the product itself adds to the rigidity of the package as with ice cream, it is quite conceivable that a snap-on or snap-over type lid will perform satisfactorily. On the other hand if the product is a semi-solid such as cottage cheese which adds nothing to the rigidity of the container, it would be wise to use a snap-in lid because all the rigidity and strength must come from the package.

With a snap-in lid it is wise to consider an all-plastic package rather than one involving a plastic base coupled with a metal or paper lid. When a metal lid is placed on a plastic container and the temperature is reduced to between 35—40°F, there is considerable danger of splitting the plastic package because of the difference in thermal coefficients of the dissimilar materials. When the paper lid is inserted into a plastic container nearly the same thing occurs, because as the paper lid absorbs moisture it swells and then as the plastic contracts with a decrease in temperature the danger of splitting again occurs. It is best to use a plastic lid on a plastic container whenever possible so both parts will have the same thermal expansion properties.

STACKING BOSSES

Containers which are to be vended or dispensed mechanically must be engineered more carefully than those which are not. Careful attention must be paid to the type of vending mechanism which will be used in order to prevent malfunctions. The most common cause of malfunction in a vending mechanism is jamming or interlocking of the containers in such a manner as to prohibit their dispensing. If the items are hot drink cups in a vending machine and a malfunction or "hang-up" occurs, the situation is far more critical than if the items are cottage cheese tubs in a dairy filling operation. While the cup vending machine is out of order there is no return on investment until a man can return to straighten things out. In a cottage cheese filling operation there is usually someone present to make adjustments where and when necessary so that down time is minimal.

The best way to prevent jamming and assure positive dispensing is to incorporate a stacking boss. The stacking boss or stacker can be located anywhere on



the sidewall of a formed container. A stacking boss is usually modified "Z" Section which can be continuous around the periphery of the formed item. It may also consist of small bosses or lugs strategically located so that they will be sure to catch and support the above container. Whenever possible it is advisable to locate the stacker near the bottom or at least at the smallest diameter or dimension possible in order to capitalize on the rigidity of the material due to the intersection of surfaces. If the stacking boss is situated near the top it can add to the flexural strength of the container. However, since the flexural strength is lowest near the mouth, the container is more subject to distortion in this thin area which may allow the above supported container to cant or tilt and subsequently slip inside the supporting container. In order to minimize this possibility, care should be taken to design the stacker so the edge of the lower ledge will fit just inside the wall on the upper ledge allowing only sufficient clearance to prevent sticking or wedging at this point. In this manner, any deformation of

containers will be minimized since the closely nested containers will add to the rigidity of the stack and even if some of the containers are distorted their close proximity will not allow them to jam. This feature is of particular significance for hot drink vending cups because of their close spacing (usually 1/4") and the fact that many are usually loaded at a time so it is quite conceivable that some of the containers could be wedged together and not be noticed. Wedging is usually a result of rough handling during shipping and since little control is available over this operation, it is best to design around it.

An important consideration in designing the stacking boss is that containers should nest as close together as possible in order to increase bulk density of stacked containers; this, of course, for more advantageous shipping rates.

Another factor which sometimes creates problems in vending and dispensing mechanisms is variation in lip diameters. This should present no problems with plastic containers; because unlike paper which will grow with moisture absorption, the plastic will not so that tolerances of a few thousandths may be consistently maintained not only around the lip, but throughout the container.

MATERIAL DISTRIBUTION

Weight and material distribution are highly important considerations because they can directly affect the economic as well as the functional aspects of a thin wall, light-weight packaging application. Material distribution is probably a more significant factor than weight because with properly distributed material a lighter weight container will often outperform one which is heavier and does not have optimum distribution.

Since there are relatively few positive controls for material distribution, the few that are available must be utilized to the utmost. We have found through laboratory study and field experience that the best way to regulate material distribution is to maintain close control over plug speeds, temperatures and depth of penetration. The most important of these factors seems to be plug temperature, especially for deep parts where the draw to minimum width ratio is 1 : 1 or greater. It has been found that by operating with plug temperatures around 330°F, the heat softened plastic sheet does not flow over the end of the plug as it penetrates the cavity, leaving a thick mass of plastic and causing a uniform stretching of the sidewalls. Then by regulating the depth of penetration the reserve material on the plug tip can be drawn off to form the bottom of the item in the desired section thickness.

This ability to vary section thickness in the lower portions of the containers is helpful because it is in this area that extra strength is most often needed to provide extra protection against breakage due to dropping. Also, now that containers are being more stylishly designed, it is possible to achieve a concave or "wine bottle" bottom without having excessively thin sections around the outer edges.

There are a number of theories on plug design to obtain optimum material distribution, especially where the container features a concave bottom. We have been most successful in forming impact polystyrene using plugs which generally conform to the cavity shape allowing about a 1/8 inch clearance per side and which have a flat bottom with a slight radius at the corners. We have tried plugs with deep dished bottom that were vented and found that this did not improve material distribution enough to bother about. The polystyrene does not flow into the concavity, but remains stretched over the end. This has the disadvantage of leaving a rather heavy section in the bottom center of the container. One method which might alleviate this situation is to place a slight vacuum on the plug which will draw the plastic into the recess, prestretching the material sufficiently to provide a uniform thickness throughout the bottom area.

A general rule of thumb for determining container weights which appears to hold true for many applications is to allow one gram of material per fluid ounce capacity. For example, a sixteen ounce capacity

container should weigh approximately 16 grams. While this will not hold true for all applications, it does serve as a basis on which to begin your study.

STRUCTURAL MEMBERS

In addition to having good material distribution, it is wise to incorporate as many structural aids as possible. Ribs, flutes, corrugations, bosses, and other features can be designed into lightweight containers adding to their structural properties as well as aesthetic appearance. The strategic use of these features will often permit a lighter weight container to serve in applications where heavier ones without them will not. In addition to providing a sturdier container, greater styling effects can be achieved with little or no sacrifice in production rates. The functions of the container will determine which structural members should be incorporated. If the container is a cottage cheese tub which will be automatically capped, the container must be designed to have good compressive strength so that it won't buckle under the pressure of the capping heads. At the same time, it must have sufficient flexural strength to keep it from being flimsy. Therefore, the structural members must withstand a combination of forces.

An example of sidewall printing. Note the clearness of the printing.

SUMMARY

Properly designed thin wall plastic containers can be produced to compete for a number of packaging markets now being served by other materials. Plastics offer design opportunities with which to ever increase the number of markets. Continuing research in materials, methods, and equipment promise to make thin wall packaging a major market for the plastics industry.

Studs

The Indian Standards Institution has just published IS : 1862—1961 Specification for Studs, which covers the requirements of precision grade studs intended for use in steel and cast iron.

Pursuant to the decision of the Government of India to adopt metric system of weights and measures throughout the country, the Indian Standards Institution has recognized the metric screw thread. The Institution is engaged in making available various standards on threaded fasteners based on the metric screw thread, and this standard is one of a series of such standards, other standards in the series being :

IS : 1363—1960 Specification for Black Hexagonal Bolts (6 to 39 mm) with Nuts and Black Hexagonal Screws (6 to 24 mm)

IS : 1364—1960 Specification for Precision, and Turned Hexagonal Bolts (6 to 39 mm) with Nuts and Hexagonal Screws (6 to 39 mm).

Mavoor Wood Pulp Factory

Production in the wood pulp section of the Gwalior rayon pulp factory started by the Birlas in Mavoor, 16 miles from Calicut, is expected to start by July next.

This was disclosed to Pressmen by Mr. G. D. Birla soon after he arrived by his own Dakota at the private airstrip constructed for the use of the factory at Chelari.

This is the first time that Mr. Birla is visiting Kerala since concluding an agreement with the Government for opening the factory in the State.

He was received by Col. T. P. Rajan, Chief Executive of the wood pulp division.

Mr. Birla thanked the Government and the public for the cooperation extended to him in starting the factory.

Modern Road-making requires economical Compacting of Soil

THE TECHNIQUE OF COMPACTING TAKES A NEW COURSE

THE time of the good old steam roller now finally is past, and that for this machine, by the load of its own weight, only succeeded in compacting enduringly the soil up to a depth of 20 cm.

The modern road-making as well as the construction of aviation fields, however, puts greater strains on the under-ground, to which only machines are equal, which make it possible to compact the soil up to a depth of 80 cm at least.

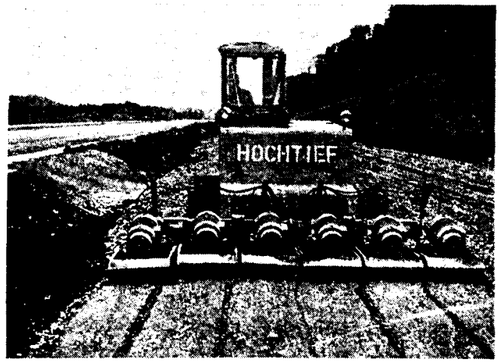
The Multi-Plate Compactor VIBROTREK R 42, manufactured by Messrs. Frankenwerk Maschinenfabrik GmbH., a Sister Company of the FLOTTMANN-WERKE GmbH., fully meets this requirement. Equipped with a caterpillar and 4–6 plates the machine is indispensable for the modern large site, for by reason of the gigantic movings of earth the technique of compacting acts a very important part.

When building the first motor-roads in the year 1935, the ground was compacted by rollers only on the surface up to approx. 20 cm, whereas in the deeper layers the cavities of the embankments were resting. The infailable consequence is the sinking of the concrete and asphalt paving, and the so much feared frost cracks. The reparations becoming necessary again and again devour immense amounts.

Construct economically and therefore compact as deep as possible! That is the first demand of the modern road-making and underground work. The FLOTTMANN Compactor VIBROTREK R 42, in case of a gravelling of 60 cm reaches a proctor density up to 115%, and even in case of a gravelling of 90 cm and after only 2 passes a proctor density of 95% was obtained.

DESCRIPTION OF THE MACHINE

The Vibrotrek R 42 is a full-track, diesel-powered, small-plate compactor especially designed for compacting soil. It can be equipped with either 4 or 6 compactor plates, giving it from 2,50 to 3,75 m (8,2 ft to 12,3 ft.) working width. The vibrating power for the compacting plates comes from electrically-driven



Multi-Plate Compactor "VIBROTREK R 42" at site of a large constructing Firm of Western Germany.

Multi-Plate Compactor "VIBROTREK R 42" with one vibrator group raised.

external vibrators. The power source for the machine is an air-cooled, 37,5 metric HP, Deutz diesel engine. This engine powers a 25 KVA three-phase generator through a clutch drive and a hydraulic pump through drive belts. The generator provides the current for the vibrator motors and the hydraulic oil pump supplies oil pressure which is used for driving the Vibrotrek. The hydraulic drive permits infinitely variable regulation of the speed and rapid reversal. Raising and lowering of the compacting plates, which is also accomplished by oil pressure, is carried out in

two groups, 2 or 3 compacting plates being coupled in right and left groups. A patented suspension of the compacting plates prevents transmission of the vibrations to the chassis of the machine proper. The transmission has a work gear with which a speed of up to 0,7 km/h (0,435 miles/h) can be attained and a high-speed travel gear with a maximum speed of 4,5 km/h (2,8 miles/h). The two steering chains are separately powered in order to ensure steering safety. The various steering and control manipulations can be carried out from the weather-protected operator's cockpit. The generator, which meets the VDE requirements, can, if necessary, also be used as an emergency current source.

ADVANTAGES

- High compacting capacity
- Large working width
- Small power requirements
- Independent mobility, can traverse rough terrain
- Work and travel gears infinitely variable
- Compacting plates have separate drives
- Vibration-free suspension of the compacting plates
- Can be used as an emergency current installation

TECHNICAL DATA

Working widths :

With 4 compacting plates
approx. 2460 mm (8′—$\frac{3}{4}$″)

With 5 compacting plates
approx. 3080 mm (10′—1$\frac{1}{4}$″)

With 6 compacting plates
approx. 3700 mm (12′—1$\frac{5}{8}$″)

Overall dimensions :

Total length in working position,
approx. 4230 mm (13′—10$\frac{1}{2}$″)

Total length in travel position,
approx. 3900 mm (12′—9$\frac{1}{8}$″)

Width of the full-track vehicle,
approx. 2500 mm (8′—2$\frac{1}{2}$″)

Total height with body
approx. 1550 mm (5′—1″)

Total height with driver's hood (removable)
approx. 2500 mm (8′—2$\frac{1}{2}$″)

Service weight
With 4 compacting plates
approx. 7170 kg (15807 lbs.)

With 6 compacting plates
approx. 8180 kg (18034 lbs.)

Speeds :

Forward travel speed, adjustable up to
approx. 4,5 km/h (2,8 miles/h)

Work speed, adjustable up to
approx. 0,7 km/h (0,435 miles/h)

Radius of turn
approx. 5,5 m (18 ft.)

Diesel engine :

Manufactured by Klockner-Humboldt-Deutz AG, Cologne-Deutz

Construction type :

A 3 L 514
3 cylinders
4-stroke, air-cooled

Capacity :

37,5 metric HP at 1500 rpm
Fuel consumption in operation,
approx. 6,5 to 7 l/h
(1,43 imp. gal/h or 1.72 US gal/h to)
(1,54 imp. gal/h or 1,87 US gal/h)

Generator :

Manufactured by A. van Kaick, Frankfurt/Main
Type : D 2 N7/4

Capacity : 25 KVA at 40°C (104°F) ambient temperature

Current : 400/231 volt in polyphase connection with zero point

Power factor : 0,8
Frequency : 50 cycles
RPM : 1500

DESCRIPTION OF THE VIBRATING COMPACTOR

The especially advantageous compacting action of the Vibrotrek R 42 is due primarily to the external vibrators and compacting plates which were especially designed for this machine.

The Frankenwerk vibrator used here develops a vibration force of approx. 4200 kg (9259 lbs.) when used at about 47 cycles. Power is supplied by a three-phase motor which is siliconized and encapsulated to keep it free from water and dust. It is therefore insensitive to temperature and moisture as well as dust. The utilization of heavy-duty roller bearings with regulated lubrication makes the external vibrator ideal for long-term heavy-duty operation.

The robust housings, moreover, make it extremely resistant to mechanical damage. The vibrating power can be adjusted to the characteristics of the soil which is to be compacted, by a simple setting of the flyweights. A patented spring construction transforms the circular motion developed by the vibrator only into a vertical action, which is then transmitted to the ground. This device damps the horizontal vibrations to such an extent that they are practically eliminated. The individual compacting plates, which have working surfaces of 2400 cm² (372 sq. in.), are so constructed as to provide the most advantages relationship between the size of the mass and the vibration and allow the plates to compact without shifting the soil. This advantageous relationship, in combination with the vibrating power, is the chief reason for the excellent compacting effect described in the accompanying excerpt from a testimonial from a well-known construction machine institution.

COMPACTING DATA

The following are values, derived from experience, which demonstrate the extraordinary compacting characteristics of the Vibrotrek R 42.

ME values and proctor compressions at various speeds of advance with respect to the number of passes.

Material : gravel depth : 60 cm (23$\frac{5}{8}$″)

Advance V		depth in		2 passes		4 passes		8 passes	
m/min.	ft./min.	cm	in.	ME kg/cm²	% Proctor	ME kg/cm²	% Proctor	ME kg/cm²	% Proctor
4,7	15,4	0	0	1153	106	1232	111	1478	115
		22	8$\frac{5}{8}$″	855	101	928	101	957	107
9	29,5	0	0	873	105	1155	105	1340	105
		20	7$\frac{7}{8}$″	—	98	920	100	980	99
		40	15$\frac{3}{4}$″	—	96	—	97	883	99

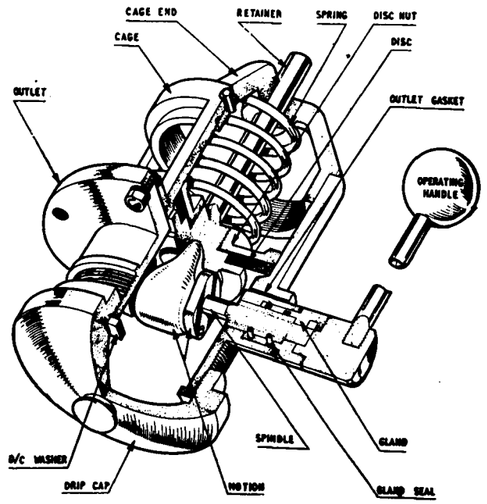
The table shows that with gravel at a depth of 60 cm (23$\frac{5}{8}$″), passes at a speed of 4,7 m/min (15,4 ft/min) gives practically the same results as 4 passes at 9 m/min (29,5 ft/min). Density and ME values at various speeds of advance with respect to the depth of the layer and the number of passes.

Practical application and tests have shown so far that a Vibrotrek R 42, equipped with 6 compacting plates (3,70m = 12,14 ft. working width), making 4 passes at 9m/min (29,5 ft/min) and an average proctor density of 100%, on a layer of gravel 60 cm (23$\frac{5}{8}$″) deep, will compact a surface of 780 m²/h (8396 sq. ft./h), that is 468 m³/h (16′527 cu, ft./h) loose or 390m³/h (13′773 cu. ft./h) compacted gravel.

Standardized Tank Fittings— Collins-Wallis Equipment

STANDARDIZED TANK FITTINGS Collins-Wallis Equipment for Bulk-haulage Bodies is based mainly on one common assembly.

Basis of many fittings in the Collins-Wallis range is a standardized cage valve unit, shown here in cutaway form. This may be used without the operating mechanism when serving as a pressure relief valve. The vitrile rubber sealing Disc is reversible.



Specializing in the supply of cocks, manhole covers, valves of numerous types, and in fact, most other fittings likely to be required for tank bodies used in a wide variety of bulk-haulage applications. Brian D. Collins (Engineers) Ltd., is a company which owes much of its success to its policy of standardization. Such a policy keeps selling prices low and substantially reduces the stock of spares which an operator need maintain.

Much of the equipment in the Collins-Wallis range offered by this company is made at the Collins factory in Harlow, Essex, but the company also acts as agents for several well-known products in the oil—and chemicals—handling equipment fields—such as Chiksan swivel joints and loading arms, Rockwell meters and "Tiona" manhole covers. Headquarters of the company is situated at 1, Cambridge Park, Wanstead, London, E.11.

Basis of most cocks (or faucets) and valves in the Collins–Wallis range is the company's patented cage valve unit, depicted in an adjacent illustration. This can be combined with many different outlets, with or without operating motions, to provide the required fitting. The cage valve unit itself can also be produced in different metals such as high-tensile brass, aluminium, bronze and stainless steel) to be compatible with the particular fluid product being handled.

Generally, the sealing washer is of vitrile rubber, but it can be supplied in butyl rubber, p.t.f.c. or "Vitron" if required. A long life may be obtained from the sealing washer because it is reversible.

When employed in a cock or manually operated valve, the cage valve unit is opened by means of a tongue on a spindle through the discharge pipe of the complete fitting. Over-centre motion holds the tongue in its fully extended position, keeping the valve open, and a slight blow on the detachable handle of this spindle is enough to close the valve sharply. Removing the handle renders the fitting proof against subsequent tampering by unauthorized persons. Normally, all fittings can be supplied to either British or Amercian design standards.

Initially the company intended to market its cage valve units separately from elbows, faucet bodies and outlets, so that customers could order parts for stock and build the fittings they required, when necessary.

However, not all customers are, as yet, receptive to this idea, so that the company markets its fittings both in whole and in part. A comprehensive catalogue, with parts lists included, enables customers to choose exactly what they require, whilst operational and maintenance instructions therein keep them fully informed on these aspects.

Top and bottom operators for the emergency valves of tank trucks are also popular "lines" in the company's range. Top operators comprise a central column which rises through 1⅜ in. up two inclined planes when turned through 90 degrees. In so doing, a cental rod attached to the column through a ball-bearing thrust race rises also and conveys this motion to the foot valve of the tank through a connecting rod hooked to it.

Bottom operators comprise single or multiple levers (up to eight in number) which are connected to the emergency valves by cables. Optional features include fusible links in the cables and an emergency knock-off lever to close all valves instantaneously. Standard provision is made for padlocking each lever, whilst another option is a manual front-end release.

For unpressurized tanks, the "Tiona" pressed steel manhole cover is well suited, being easily fitted to the tank neck-ring and readily opened by an operative wearing even the thickest winter gloves. Closing the cover is merely a matter of kicking it down, when it seals itself automatically.

Modified by the Collins concern to suit Home Office petroleum regulations, this manhole incorporates a vent valve which will not premit loss of product should the tank vehicle overturn. Other types of manhole, for pressurized as well as unpressurized tanks, are available, whilst the company also markets different types of relief valve for pressurized tanks and pneumatic conveying systems.

Amongst the relief valves, for special applications, which are standard products of the company might be mentioned the Collins Dairy vent valve. Designed for use with tanks where scrupulous cleanliness is essential, this valve has no crevices or springs which might introduce contamination hazards. Manufactured in aluminium alloy, it has a diaphragm of sweetened rubber which is readily removable for cleansing.

Thermal Plant at Neyveli

The pre-commissioning tests on the first unit of the thermal power station at Neyveli had proved successful and were expected to be completed by the end of this month, said Mr. A. Srinivasan, Deputy General Manager, Neyveli Lignite Project, in a Press interview.

Mr. Srinivasan said that it had been planned to increase the power potential of the thermal plant from 2,50,000 to 4,00,000 K. W. The plan envisaged the setting up of seven units, of which five were expected to be commissioned by the end of 1963. After the first unit was commissioned, the Deputy General Manager said the other four units would be in operation at intervals of four to five monts. The sixth unit, also of 50,000 K. W. capacity was expected to be commissioned during the middle of 1964. The seventh and the largest unit, with a generating capacity of about 1,00,000 K.W. was expected to be ready at the end of the Third Five Year Plan.

Mr. Srinivasan said that the final shipment of equipment for the first five units for the thermal station, which was being built with Soviet credit had reached Madras. He said "Indian Splendour" had docked in the Madras Harbour carrying about eight heavy loads of equipment from the Soviet Union. The loads were over 60 tons each, with two loads weighing over 100 tons each. All the equipment would be unloaded at the Harbour and transported to plant site, at Neyveli, at quick intervals, he added.

He said that the extension from 2,50,000 to 4,00,000 K. W. had already been accepted by the Planning Commission and an officer of the Government of India in the Central Water and Power Commission was recently in the Soviet Union to finalise the details of the scheme.

Mr. Srinivasan said that each unit of the power station would consume about 0.3 million tons of lignite annually, and the present mine was capable of meeting the demands of the eight units of the thermal station. He said it was their ultimate aim to increase the target of power production to about 600 megawatts during the Fourth Plan.

Unit Construction System in Design of Piston Compressors

By Dr.-Ing. G. Chone, DEMAG, Germany

PROFITABLE sales is the aim of all manufacturers, and every department, from workshop to despatch, must at all times keep this in mind. The special attention of management will be devoted to planning the production range. A progressive manufacturer will constantly keep his range under review and concentrate on the minimum number of standard models which will effectively cover maximum demand. In the development of a new product, every effort will be made to keep the model range as compact as possible. This article describes how the designers of a range of compressors rose to this challenge.

The first step in planning the new range was an exact defination of applications and capacities, including media to be compressed, pressure ratios, delivery capacities and efficiency factors. This determined some of the major design specifications, such as speed, number of stages and type of cooling. However, as soon as designers began to consider the number of cylinders, arrangement of stages and type of drive, the problem of production costs had to be borne in mind. This is not to say that simple components produced at low cost were the aim. The emphasis was rather on designing a whole range having the maximum number of components in common. The principle of employing standard components in piston compressor design is by now well established. Standard drives are used, but number, size and arrangement of cylinders vary, the range of cylinder sizes, valves and cylinder heads being kept to the minimum.

A typical example of the unit construction system is the range of compressors, giving rated deliveries from 1.5 to 4.5 m^3/min. (53—160 cu. ft./min) at final pressures of 2 to 14 atm. (29—200 lbs/sq. in.). Standard components used over the whole range include drive, housing, valves and cooling blower, while others, such as cylinders, cylinder heads and fly-wheels, are standardised for 2 or 3 sizes.

This method of incorporating standard components permits low-cost long runs of individual parts, while still leaving room for assembling models to suit customer's individual requirements.

In planning the new range of water-cooled compressors, the designers aimed at compact, self-contained unit components which could be assembled into a number of different models. This exclusive concentration on the unit construction system not only substantially increased production efficiency and economy, but also had a decisive influence on design and development. The customer may not care very much whether his compressor is built up of many uniform standard components, except in so far as they lower the purchase price. But when it comes to ordering and stocking spare parts, he is bound to welcome the system. Apart from lowering production costs, unit construction offers the additional advantage that the manufacturer can meet wider market demands with a smaller stock. By merely assembling his basic standard units in a different arrangement, he can offer another model, thus keeping delivery periods to the minimum.

The compressor range described here is arranged for water-cooling and covers rated delivery from 5—17 m_3/min. (175—600 cu. ft./min). It is available in single and two-stage design, the two-stage version giving a service pressure of 12 atm. (175 lb/sq. in.).

Rated speed of the entire range has been fixed at 1,000 r. p. m. Higher speeds reduce both relative compressor weight and operating economy, and extensive tests of machines of this size showed that 1,000 r. p. m. provided the optimum compromise. Compressors can, of course, also be driven at lower speeds.

A V or twin-V cylinder arrangement was selected, as this reduced dynamic forces to an unimportant level. Vibration is low and kept well within acceptable limits. Cylinders are multi-stage units. In the two-stage type, the first stage compression is produced in the main cylinder chamber, the second in the annular piston chamber facing the drive unit. The intercooler required between the two stages is built into the cylinder assembly, so that each cylinder is a self-contained unit, ready for connection to the air inlet and outlet lines. The range includes two such cylinder units, one delivering approx. 140 cu. ft./min, the other 88 cu.ft./min. at 1,000 r.p.m. Similarly, there are two drive units, one accommodating two cylinders, the other four. All

cylinder units can be combined with either of the two drives in any desired manner. From these basic units, a number of models covering a wide capacity range could be assembled, but the aim is to concentrate mainly on a minimum number of the most popular sizes. The two-stage cylinder unit is so designed that its second stage can be arranged in parallel with the first to give a single stage model without intercooler. Air and cooling water lines are again grouped into standard assemblies which can be fitted to all standard units.

Unit construction makes each cylinder virtually into an independent compressor whose delivery can, where required, be controlled separately from any others.

Compressors are powered by direct electric drive. The motor is flange-mounted on the compressor to give a self-contained assembly. Compressors are very carefully dynamically balanced, so that they require no foundations, the rubber feet being held in mountings dimensioned to cope with critical service loads. Thanks to this excellent balancing of forces, vibration of the machine when running is quite imperceptible, except on starting and running out.

Cooling water consumption is a problem which assumes increasing importance in the efficiency and operating economy of modern compressors. Since thermo-dynamic principles determine the volume of heat to be transferred per cu. ft. of air at any given compression ratio, cooling systems should be designed to transfer the heat to the smallest possible volume of water compatible with efficient cooling performance. Consequently, cooling water outlet temperatures are bound to be high, and this must be taken into consideration at the design stage. To save cooling water, the flow circuit has been so arranged that the water first runs through a compressed-air after-cooler before entering the machine. Return coolers to cool the recirculated water by air are also fitted, as is customary in modern designs. The return cooler, complete with internal air cooling duct, fan and cooling water pump, has also been designed as a self-contained assembly which can readily be installed separately from the compressor to give the most convenient layout. Several return cooling units were developed to suit various compressor sizes. Excellent balancing of forces, light-weight construction and availability of a return cooler make the new compressor range suitable for use as mobile plants.

To sum up unit construction offers decisive advantages to the producer in design, efficient production and forward planning, because he can concentrate on long runs of standard units, from which he can then assemble a wide model range. For the user, the advantage of the unit construction system include the reduced number of standard spare parts, which minimise his stock problem, and the fact that long production runs keep down the cost of replacement parts.

Code of Practice for Installation and Maintenance of Transformers

The Indian Standards Institution has published IS: 1886–1961 Code of Practice for Installation and Maintenance of Transformers. This code applies to the installation and maintenance of power transformers covered by IS : 1180–1958 Specification for Outdoor Type Three-Phase Distribution Transformers Up to and Including 100 kVA 11 kV, and also to higher capacity transformers which would be covered by future Indian Standards.

This code of Practice is intended to serve as a guide to installation engineers, contractors and users of power transformers. To ensure the best possible service under the conditions generally existing in this country, a schedule on maintenance has been included. Apart from the information concerning transformers themselves the code gives additional information regarding ancillary work, such as cabling, connecting surge protection, etc.

In view of the consideration that this Code is required to be in conformity with the prevailing practice in the country, considerable assistance has been derived from the Indian Electricity Rules, 1956 while drafting the code. Reference to the relevant provisions of the Indian Electricity Rules 1956 has, therefore been made in appropriate places with a view to bringing to the notice of the installation and maintenance engineers all the statutory regulations concerning this work.

Metric system has been adopted in India and all quantities and dimensions in this Code have been given in this system.

TEST REPORT

Test Runs with the Diesel Hydraulic Locomotive ML 4000 C' C' with Dynamometer Car

BY

Dr. Ing. E. h. Oskar Stamm, Vorsitzer, Erich W. O. Busse, Paul H. v. Mitterwallner · Vorsitzer des Aufsichtsrates: Dr. Ing. E. h. Franz Grabowski

THE 4000 H.P. locomotive designed by Krauss–Maffei for U.S.A. railroads is at present the world's most powerful diesel-hydraulic locomotive. It has been developed from the diesel-hydraulic six-axle locomotives of 2200 H.P. and 3000 H.P. built by Krauss–Maffei in the past years. In the same way as the preceding types, this locomotive has been subjected to exhaustive tests. The measuring tests were again carried out in co-operation with the German Federal Railway's Experimental Station, Experimental Test Department for Internal Combustion Engines, of Munich.

An essential novel feature of this locomotive is that it incorporates a first-time built hydro-dynamic brake attached to the hydraulic transmission in such a way that the two of them constitute a self-contained constructive unit.

EXECUTION OF THE TESTS

The test runs were carried out from March, 17th to 21st, and April, 19th to 23rd, 1961, on the line Munster–Emden. As braking load at the end of the test train two heavy goods train steam locomotives " Class 45 " for the speed range 0—80 km. p.h. (0—50 M.P.H.), and for the speed range 80—110 km, p,h. (50—86 M.P.H.) two express train locomotives " Class 18⁴ " of the German Federal Railway used. The German Federal Railway prefers to use braking locomotives for measuring tractive efforts as only with this method is it possible to bring about such constant speed conditions as required for correct measuring. On gradients with their ever-changing track resistances, such favourable conditions are quite exceptional. The braking locomotives with their controlled counter-pressure enable precisely adjusted brake effort constants to be achieved throughout the entire speed range. The track Munster-Emden is especially appropriate for the test under consideration as it runs over flat land with but slight differences of level and few curvatures.

The train used for testing consisted of one diesel-hydraulic locomotive ML 4000 C'C', one dynamometer car, one by-car, one equipment car, and the two braking locomotives, in each instance.

In the direction Munster-Emden, the tractive efforts of the locomotive were measured, and in the opposite direction the braking efforts, the steam locomotives serving as braking locomotives in the one direction, and as traction engines in the other.

Tractive effort at draw hook (Z_h) was ascertained by means of a measuring member fixed between the locomotive and the dynamometer car, and it was recorded by an electronic compensator. Elongation meter strips served as transmitters reacting to every elongation of the draw spindle as caused by the traction force in such a way that their ohmic resistance is being changed in proportion to the acting force. The running speed V was measured by means of an A.C.—tacho-generator attached to one of the axles of the dynamometer car, and recorded by a voltage-sensitive compensograph. Fuel consumption of the two diesel-engines was gauged by a piston type counter and recorded through electric transfer lines by counting relays located in the dynamo meter car.

Pressures in the main and secondary circuits of the hydrostatic of the cooler fans were measured by means of pressure cells and recorded in a 12-point recorder. The speed of the diesel engines were further recorded and all important temperatures of air, water, and oil were taken in two 12-point recorders.

RESULTS OF THE TESTS

Fig. 1 is a tractive effort/speed diagram in which the measured tractive efforts at the draw hook are compared with those which had been previously calculated. When comparing these two graphs, allowance must be made for the fact that the calculated values apply to a diameter of half-worn wheel tyres, but the

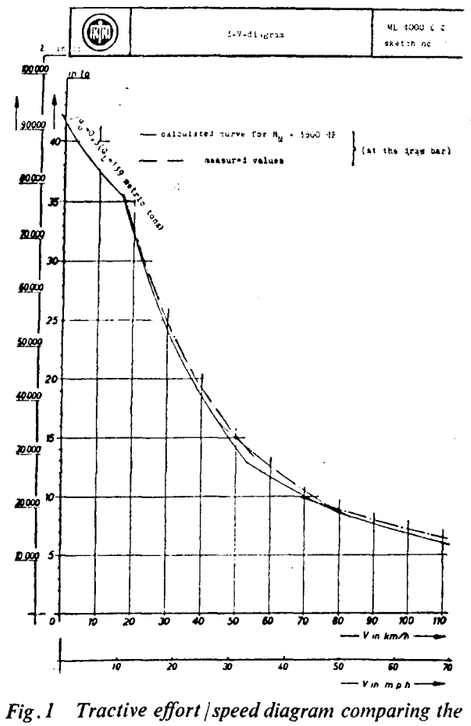


Fig. 1 Tractive effort / speed diagram comparing the theoretical with the measured effort at draw hook

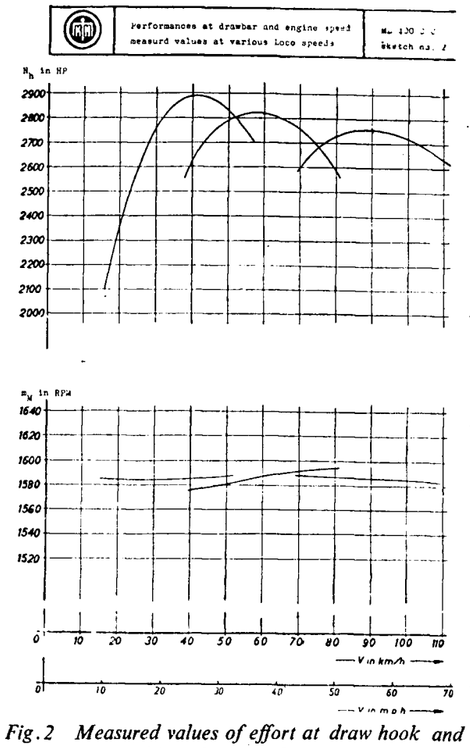


Fig. 2 Measured values of effort at draw hook and engine speed in relation to locomotive speed

measured ones, of course, to new tyres. Consequently, even if the two graphs did not exactly coincide with each other, this would prove the measured tractive effort to be higher than the pre-calculated one. Either diesel engine was adjusted to 1,900 H.P. at 1,580 RPM.

Fig. 2 shows the measured effort at the draw hook and the engine speed as a function of the running speed. This graph makes evident that there occur but little steps at the change-over points from converter to converter, and that engine speed remains almost constant at these points.

Fig. 3 illustrates the brake efforts obtained by the hydro-dynamic brakes of both power plants. As this graph includes the running resistance of the locomotive, the latter has to be substracted ; its values are registered at the lower part of the diagram. The curve showing the measured values is a steep parabola rising in conformity with speed increase, which corresponds to the characteristics of hydraulic couplings. The whole realized brake effort is transformed into heat which has to be dissipated through heat exchangers and coolers the capacities of which put a limit to the available brake power. The actual cooling capacity corresponds to an output of 1,400 H.P. of each engine as expected to be available at site, viz. 50°C (122°F) of ambient temperature. For these reasons, tests with varied brake effort adjustments were carried out in the critical cooling range in order to have these thermic limits precisely checked.

Fig. 4 reproduces measurings of the tractive effort at the start. In order to obtain exact test values, every change-over from speed step to speed step was made only after a state of permanent speed had been accomplished. To this effect, the test train was braked and the brake of the diesel-hydraulic locomotive released with the independent air brake valve. During this test, which lasted for 2 minutes and 34 seconds, no thermic overstrains occurred.

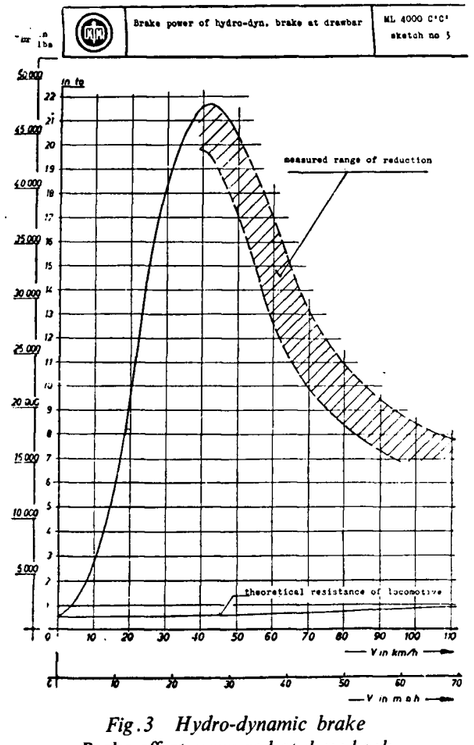


Fig. 3 Hydro-dynamic brake Brake effort measured at draw hook

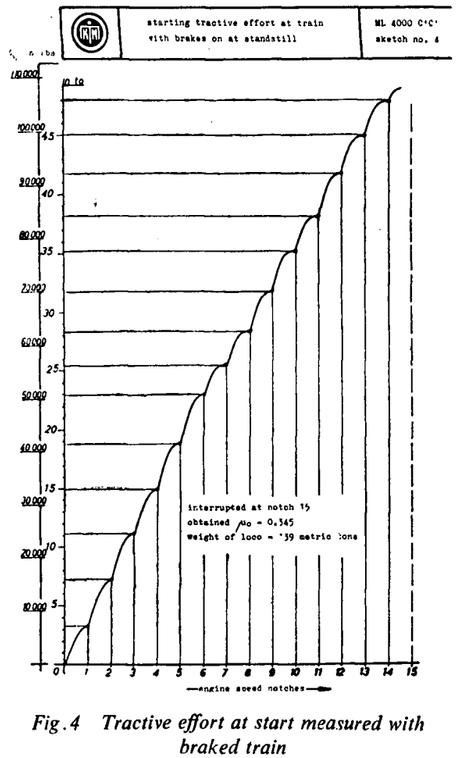


Fig. 4 Tractive effort at start measured with braked train

SUMMARY

The tests have given unambiguous information about the performance of the diesel-hydraulic locomotive ML 4000 C'C'. In particular, they proved the consistency of the measured values with the calculated ones, and that in some cases the latter exceeded. Worthy of emphasis are the unobjectionable and smooth running of the locomotive over the whole speed range and the extraordinarily low noise level inside the cab.

When the hydro-dynamic brake was tested, one of the most impressive occurrences was that two of the heaviest German goods trains locomotives were unable to accelerate the train to speeds exceeding 30 km/h (19 M.P.H.), against the braking power of the hydraulic locomotive. It may be mentioned in this connection that, when the efficiency of the hydro-dynamic brake was being demonstrated, the test train, weighing 650 metric tons, was almost brought to standstill from a speed of 80 km/h (50 M.P.H.) over a horizontal distance of 800 metres (875 yards), although this brake is intended to be used on slopes only.

In conclusion, it may be affirmed that the thorough test runs carried out by the German Federal Railway's Experimental Station, Experimental and Test Department for Internal Combustion Engines, of Munich, have proved the measured values to be fully in accordance with the calculated ones.

MANUFACTURE OF DIESEL ENGINES

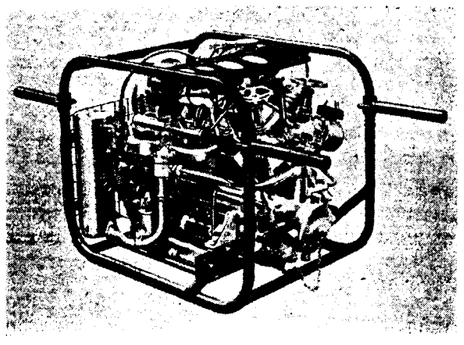
The Government have decided to undertake the manufacture of diesel locomotives at the locomotive components works at Varanasi, in Uttar Pradesh. Moreover sufficient land, building and water supply were available at Varanasi. The question which foreign firm would collaborate with the railways for the manufacture of the locomotives was still to be decided.

TWO NEW MODELS FROM COVENTRY CLIMAX

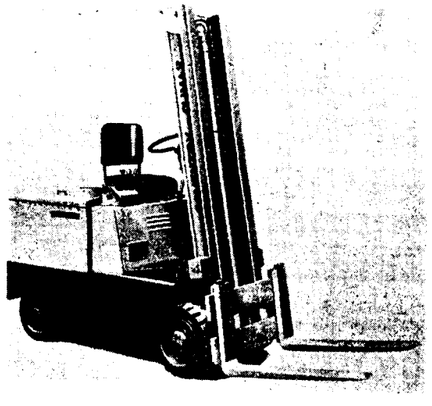
COVENTRY Climax Engines Limited (England), makers of the famous motor-racing engines, have recently introduced several new models to their range of fork lift trucks and mobile fire pumps.

In answer to the demand from Fire Service Authorities both in the United Kingdom and abroad, for a pump even lighter than the world famous "Featherweight" model FWP, and yet powerful enough to be a really effective fire-fighting unit. Coventry Climax have designed the FWMP which meets the need perfectly. With its light alloy 4-cylinder overhead camshaft engine, it weighs only 250 lb when fully fuelled, and yet delivers over 250 Imperial g. p. m. at 100 p. s. i. pressure. Housed in its protective, tubular steel frame, the dimensions of which are only 30¾" long × 20¾" wide × 23⅜" high, it is probably the smallest and lightest pump for its capacity in the world. With such compact measurements it can be neatly fitted into a small compartment in any fire tender, and many Fire Services throughout the world are finding it an indispensable part of their fire-fighting equipment. In Canada, for instance, with the problem of exercising fire control over its huge areas of forest and brushland, a new, miniature fire tender, of which the FWMP is the most vital component has been designed to reach places which would be completely inaccessible to more conventional appliances. This ultra-lightweight pump is also doing sterling service in other parts of the Commonwealth, notably in Australasia. The FWMP is the latest and most logical outcome of Coventry Climax's unique experience in producing lightweight engines for both fire-pumps and racing-cars, the basic requirements for each of which are extreme lightness and a very high power to weight ratio.

This versatile company are also manufacturers of fork lift trucks and, in fact, were the first to introduce them on to the British industrial scene shortly after the Second World War. The design and efficiency of their trucks have made great strides since those early models until today, their "Universal" range of Diesel, Petrol l. p. g. and Electric powered trucks are the most extensively used in Britain. Always striving for improvements to existing designs, Coventry Climax have recently introduced several new models including the "Universal" Electric Model IGEV which has a lifting capacity of 5000 lb at 24 in. centres. An entirely new feature of the IGEV and one which is to be a standard fitting on all Coventry Climax fork trucks in the future, is its double—"I" beam mast which gives the greatest possible strength and resistance to torsional stresses. Its nested beams and single chain give the operator maximum forward visibility. The IGEV is the largest of the new "Universal" Electric range of fork lift trucks and has the high degree of interchangeability which is a feature of all the models in this series. It will be shown to the public at the Mechanical Handling Exhibition which is being held in London during May, 1962.



The Coventry Climax FWMP portable fire-pump. Weighing only 250 lb fully fuelled, it nevertheless delivers 250 Imperial g.p.m. at 100 p.s.i.



The Coventry Climax "Universal" Electric Model IGEV Fork Lift Truck, which has a lifting capacity of 5000 lb at 24 in. centres

POLYPENCO ENGINEERING INDUSTRIAL PLASTICS

By A Technical Journalist

THE use of plastic materials throughout the world has increased at a very rapid pace during the last 15 years and plastic products too numerous to mention are now household items. Industrial uses of plastics have also increased during this time, but even today a large number of design engineers are still unaware of the progress made in this field and many plastic raw materials and semi-finished shapes are now available, which have been developed especially for the mechanical, electrical and chemical industries.

The Polymer Corporation of Reading, Pennsylvania, U.S.A., has pioneered the development of Engineering Plastic extrusions and fabrications and is now universally considered to be the leading manufacturer of Nylon and Polytetrafluoroethylene ("TEFLON") extruded shapes.

The Polymer Corporation has an associated manufacturing Company situated at Welwyn Garden City, Hertfordshire, England, named Polypenco Limited and associated sales companies in Western Germany and France. In addition, joint agents of both Polypenco Limited and The Polymer Corporation are situated in major world markets, including India.

A description of these Polymer products and applications thereof in the engineering industries forms the basis of the remainder of this article.

THE NYLONS

Nylon is the generic term applied to a family of thermoplastic polymeric materials known technically as polyamides. It is important to realise that many grades of nylon exist within this family and that each type is characterized by specific properties peculiar to itself. The correct choice of nylon for a specific engineering application can thus often spell the difference between ultimate success or failure and advice should be sought from a reputable organisation if in doubt.

Mention should first be made, therefore, of Nylon 66– which is recognised as the hardest and strongest *standard* grade of nylon available in a very wide range of semi-finished extruded shapes. Nylon 66 is available from Polypenco Limited in the forms of extruded round rod, tubing, strip, plate, discs, hexagonal bar, square bar and machined finished components. The material, in common with all other grades of nylon, may be readily machined by similar techniques to those recommended for machining brass, using copious supplies of coolant during the machining operation. Nylon 66 is used in a wide variety of mechanical applications for the manufacture of gears, bushes, rollers, cams, seals, washers, insulators, screws and coil formers. Tubing may be used for air, fuel and hydraulic pressure lines. A high pressure nylon braided hose is also manufactured by Polypenco Limited and marketed under the trade name 'NYLAFLOW", for similar applications where higher pressures are involved.

The inherent self-lubricating qualities of Nylon 66 have contributed to its use in many bearing and bush applications. Designers, however, are always searching for improved materials for specific applications and as a result The Polymer Corporation developed a premium grade of Nylon 66, incorporating a filler of molybdenum desulphide, specifically for high wear resistant applications such as bushes, bearings, wear strips and the like. The properties of this material, called "*NYLATRON GS*", may be compared with Nylon 66 from the property chart (Figure 1).

Polypenco "Nylatron GS" is available in all the above mentioned semi-finished shapes obtainable in Nylon 66 and may be readily machined to close tolerances. In addition, "Nylatron GS" moulding compound is obtainable and may be readily injection moulded on orthodox injection moulding machinery. Polypenco's "Nylatron GS" provides several new 'PLUS' properties giving optimum performance in most mechanical applications as follows:—

Improved wear resistance— "Nylatron GS" parts will operate at higher loads and speeds than other grades of nylon and will often show increased life of up to 50% under similar working conditions.

Lower Surface Friction—The "built-in" lubricant, molybdenum disulphide, reduces the coefficient of

FIGURE I

AVERAGE PROPERTY VALUE CHART

Property	*Units*	*Mc. Nylon 901*	*Nylatron Gs.*	*Nylon 66*	*P.T.F.E.*	*Fluorosint*
Specific Gravity	—	1.16	1.14	1.14	2.1–2.3	2.3–2.4
Tensile Strength at 23°C	P.S.I.	11,000–14,000	12,300	11,800	1500–4000	2000–2500
Modulus of Elasticity at 23°C	P.S.I.	350,000	575,000	400,000	90,000	190,000
Heat Distortion Temperature at 66 p.s.i.	°C	218	232	182	132	>250
Coefficient of linear Thermal Expansion	in./in./°F	5×10^{-5}	3.5×10^{-5}	5.0×10^{-5}	5.5×10^{-5}	1.1×10^{-5}
Flammability	in./min.	Self-extinguishing	Self-extinguishing	Self-extinguishing	Non-inflammable	Non-inflammable
Dielectric Strength– short time	volts/mil.	500–600	356	385	400–500	450–500
Dielectric Constant– 10^6 cycles	—	3.1	3.5	3.4	2.0–2.1	3.5
Power Factor 10^6 cycles	—	.02	.04	.04	<.0005	.0005
Water Absorption	% in 24 hrs.	.8–1.14	1.5	1.5	Nil	Nil
Chemical Resistance	—	Good to alkalis, solvents & dilute acids.	Good to alkalis, solvents & dilute acids.	Good to alkalis, solvents & dilute acids.	Outstanding	Outstanding

friction and enables parts to operate at higher ratings with little or no lubrication.

Higher strength and Greater Rigidity—Both Tensile and Compressive strengths are increased and deformation under load is reduced. "Nylatron GS" parts exhibit a 40% increase in modulus of elasticity over Nylon 66.

Superior Heat Resistance—"Nylatron GS" components resist distortion at temperatures up to 160°C compared to 90°C for Nylon 66.

Improved Dimensional Stability—With a coefficient of linear thermal expansion less than 65% of Nylon 66 and a slower rate of moisture absorption, "Nylatron GS" components maintain better fits and clearances and thus show less tendeney to bearing failure.

"Nylatron GS" is being successfully used throughout the world for the manufacture of wear strips for conveyor systems, thrust washers in electric motors and electronic and mechanical assemblies, in applications as bearings and bushes such as railway carriage and locomotive brake linkage bushes and many other bearing applications were trouble-free operation with no lubrication or under abrasive and dusty conditions is essential.

"Nylatron GS" wear strips on luggage bay floors in aircraft, on keels of small sailing dinghys, for ease of drawer sliding in office furniture and for guide plates on elevator shafts are other examples of the use of this material.

The latest Polypenco development in the industrial nylon field is *MC NYLON*. This material, properties of which are shown in figure 1, is a completely new grade of nylon manufactured exclusively by The Polymer Corporation and its subsidiaries. Bacically a type 6 formulation, the properties of MC Nylon are equal to, and in some instances superior to, conventional nylons.

However, the significance of the introduction of MC. Nylon lies in its ability to be cast at atmospheric pressures coupled with freedom from internal stress. In practical terms, this means that there is no limit to the maximum size of MC. Nylon rods, tubes, plates, discs and similar cast items which can be produced. Hitherto, injection moulding or extrusion techniques of production of orthodox nylon compounds have limited the maximum sizes available due to high tool cost and the development of internal strain produced

Fig. 2 A 4½-foot diameter gear made of Polypenco MC nylon produced by Polypenco's new monomer casting process which for the first time permits production of large nylon parts at low cost.

during the cooling cycle.

Additionally, massive nylon *custom* castings may now be produced in MC. Nylon to existing patterns thus eliminating waste of material and many expensive machining operations. An example of an MC. Nylon casting of medium size is shown in Figure 2.

The advent of MC. Nylon has opened up many potential applications in medium and heavy industries where the properties of nylon may be utilised in the new large availabilities. High impact strength, light weight, non-galling and—corroding characteristics and sound-deadening properties in a material of a similar cost to bronze on a size for size basis will obviously appeal to many engineers.

Existing applications for MC. Nylon include massive gears cast to patterns supplied for rubber mills, back-up rollers and roller covers used in the paper and linoleum industries, rollers in steel and metal fabrication shops, truck wheels and tyres, cams for automatic lathe users and manufacturers, and forming rollers. Tools such as drill jigs and forming punches are also being made from MC. Nylon plate and castings, whilst massive bearings for rotary guillotines, dockside cranes and slipper block bearings in steel rolling mills are now undergoing long life tests.

THE FLUOROCARBONS

("TEFLON" and "FLUON", hereafter referred to as P.T.F.E.)

P.T.F.E. is unique amongst thermoplastic materials by virtue of its wide operating temperature range of -260°C to +260°C and its resistance to chemical attack even at elevated temperatures. P.T.F.E. also has outstanding electrical resistance properties as shown in Figure 1. Polypenco Limited manufacture a range of P.T.F.E. semi-finished shapes including rod, tube, tubing, electrical sleeving, tape, sheet and custom machined components.

This unique material is finding ever-increasing uses in the fields of chemical and electrical manufacture. Applications in the chemical industry include P.T.F.E. gaskets, 'O'-rings, seals and bellows. Valve seats in chlorination and similar equipment, packings, diaphragms and bursting discs are also machined from P.T.F.E. rod and tape. Component parts for pumps handling hot and cold acids and solvents such as bearings, agitators, mixers, feed tubes, and liners are fabricated from P.T.F.E. semi-finished shapes.

P.T.F.E. also has an extremely low coefficient of friction and inherent "anti-stick" properties which extend its use to non-stick liners on heat-sealing jaws and in food mixing equipment such as bakers' dough roller covers.

"FLUOROSINT" is another new Polypenco product developed from P. T. F. E. base resins and special ceramic type fillers. Unfilled P. T. F. E. is unfortunately too soft under compressive loads and dimensionally unstable, thus precluding its use for many applications such as dielectric spacers and chemical pump bearings. Polypenco's "Fluorosint" (see properties in figure 1) has a very low coefficient of thermal expansion—similar to aluminium and about 1/6 that of P.T.F.E.- and better all-round dimensional stability. The new material may be readily machined from semi-finished shapes such as rod, tube, sheet or tape or may be compression moulded to close tolerance finished parts by Polypenco Limited to customers' drawings. "Fluorosint" valve seats are harder, more dimensionally stable and may be machined to tolerances approaching those obtained with similar sized metal components.

Applications of "Fluorosint" include the manufacture of piston-rings for air compressors and humidifiers which operate without lubrication, pump seals and bearings in the chemical plant industry, tube positioners in tunable stalo oscillators in signalling equipment, radome bearings, insulators, wave-guide components, bearings in dental drills, close tolerance gaskets and dielectric spacers in radar equipment.

In conclusion, it must be stated that this article does not encompass all of the "Polypenco" range of Engineering Industrial Plastics or even fully describe the properties and applications of those mentioned. Brochures describing "Polypenco" products in full and sales and technical advice and assistance may be obtained directly from the "Polypenco" Agents in India who are:—

Asiatic Traders, 99, Bhajipala Lane, Bombay-3 Tel. No. Bombay 30383.

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(Sd.) **T. S. Nagaraja Rao**

Signature of Publisher

New ZEISS-JENA Instruments at the 1962 Leipzig Technical Fair

By Dr. Rudolf Jobst, Jena

As at every Leipzig Fair, the VEB Carl Zeiss JENA exhibits also at the 1962 Leipzig Fair an array of new instruments, constructional units and elements which are bound to be of interest to the professionals of a large variety of scientific and engineering branches. In the following review only those particular products are discussed which afford new possibilities for physicists, chemists and engineers in research, development and production activities.

In harmony with the ever growing importance of medical and engineering services, new types of microscopes and supplementary elements have been designed to satisfy the requirements of modern microscopical methods of examination.

The Universal "Nu"—Research Microscope (Fig. 1), conceived by Bruno GERSTENBERGER, Optical Engineer and developed by the engineers JURSCH, HERR and SEBASTIAN, represents a top-flight product of opto-scientific instrument manufacture. The outstanding features of this microscope may be summarised as follows :

Facilities of applying numerous methods of examination to the same specimen ;

Extensive interchangeability of instrument components without the need of re-establishing the original optical and mechanical adjustments ;

Optional employment of four light sources ensuring observation and photomicrography under perfect illuminating conditions ;

An eleven-step illuminating variator allows finest regulation of image-brightness, whilst in colour photography it affords the grading of exposure periods to an extent not otherwise attainable.

The following methods of examination may be carried out with the Universal Research Microscope "Nu", viz :

Transmitted light : Bright-field, Dark-ground, Phase-contrast, Fluorescence, Polarization :

Incident light : Bright-field, Dark-ground, Phase-contrast, Fluorescence, Polarization, Interference and Hardness testing ;

Combined Transmitted and Incident light :

	combinable with
Transmitted light—Bright-field	Incidence—Bright-field
Transmitted light—Polarization	Incidence—Polarization
Transmitted light—Fluorescence	Incidence—Fluorescence
Transmitted light—Dark-ground	Incidence—Dark-ground
	Incidence—Phase contrast

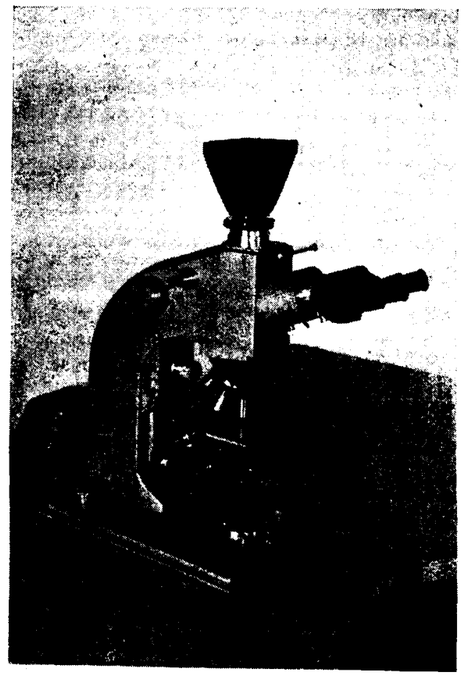

Fig. 1. Universal Research Microscope "Nu"

This remarkable versatility has been attained by the extensive degree of interchangeability of important constructional units which, in addition to filters, objectives, eyepieces and condensers, also refers to condenser-supports, stage-carriers, object-stages, objective changing-devices, tubes, camera attachments and illuminants.

The equipment of " Nu "—Microscopes with two pancratic systems, i.e., with lens systems having a controllably and reproducibly variable focus, imparts to this type of microscope a salient position amongst the best the world's markets have to offer. The pancratic illuminating system optimally exploits the light-flux of the illuminant while at the same time the pancratic eyepiece-system does away with the time-consuming change of eyepieces during observation. Observation is in general carried out binocularly at a viewing angle of 20° (monocular tubes only being used in polarization work as well as when measuring the length in objects or in fluorescence work, if called for).

An extraordinarily large and flattened field is obtained when using plane-field achromatic objectives both in visual observation as well as in photography. By means of the Photomicrographic Attachment photographs may be taken on the formats 24 x 36 mm. or 24 x 24 mm, same as on 6 x 6 cm. film or plates (standard cine film for the narrow-gauge format and plates, plane or roll film for the 6 x 6 cm. format. The Zeiss Automatic Exposure Control is likewise available for use with the " Nu "—Microscope. For microscopists the following information about the universality, versatility and operating comfort of the " Nu "—Microscope may be of interest :

Illumination : 6 V 30 W and 12 V 100 W Filament Lamp, Xenon maximum pressure lamp " XBO 100," Mercury maximum pressure lamp HBO " 50 " incl. Collectors, Field-stops and Diffusing screens optionally and combined applicable ; 2-sets of filters of 19 filters each ; Pancratic Illuminating System with triple condenser turret, interchangeable for special type condenser and condenser support ; Combined Incident-light Condenser, Luminous Variator for 11 steps of brightness.

Specimen Stage : Interchangeable, 4-models

Objectives : For transmitted and incident light : Plane-field Achromats 4x/0, 10 oo/–, 10x/0, 20 oo/–.

Objectives : Transmitted light : Plane-field Achromats 25x/0.50 oo/0.17 ; 63x/0.80 oo/0.17 ; HI 100x/1.30 oo/0 (For polarization-microscopy the objectives can be supplied in strain-deficient mounts).

Plane-field Achromats for variable phase-contrast work in transmitted light : 10x/0.20 oo/– Phv ; 25x/0.50 oo/0.17 Phv ; 63x/0.80 oo/0.17 Phv ; HI 100x/1.30 oo/0.17 Phv.

Change of Objectives either by Quintuple Turret or by centring type of change-slide.

Eyepieces : PK 12.5x, PK 12.5x adjustable, PK 10x/w and PK 16x/w (for polarization work) ;
Micrometer eyepiece K 15x ;
Pancratic eyepiece 0.63 to 2 x

Range of Magnification :
32x to 250x0 total range
50x to 1300x ABBE effective range

Viewing angle : 20°—inclined eyepiece, binocular or monocular

Photography : Plates, plane film, film-pack and roll-film 6 x 6 cm, standard cine-film 24 x 36 mm.

Exposure measurement (in the direct and pancratic optical path),

Imaging scale : 16 : 1 to 1 to 1000 : 1 on the negative.

Continuously greater importance is being attached in the metallographic branch to the determination of micro-hardness, be it for distinguishing intermediate phase crystals in light-metal alloys and carbidic steels or for ascertaining of crystal—segregations as well as in research of the structural composition of wear-resistant alloys and anti-friction metals, furthermore for the hardness-continuity in very thin surface-layers, such as nitrated, case-hardened and eloxadized layers, in metallic coatings, soldering seams etc. In the development of these techniques the Zeiss Micro-Har-

dening Tester " D 32 " as suggested by HANEMANN plays a decisive part. Its applicability—which hitherto was restricted to the Large Inverted Incident-Light Microscope " NEOPHOT " — is now being extended to the " EPITYP 2 " Microscope designed for metallographical routine investigations.

The "*EPITYP 2*" *Incident-Light Microscope* (Fig. 2) is an inverted type of bright-field microscope, small

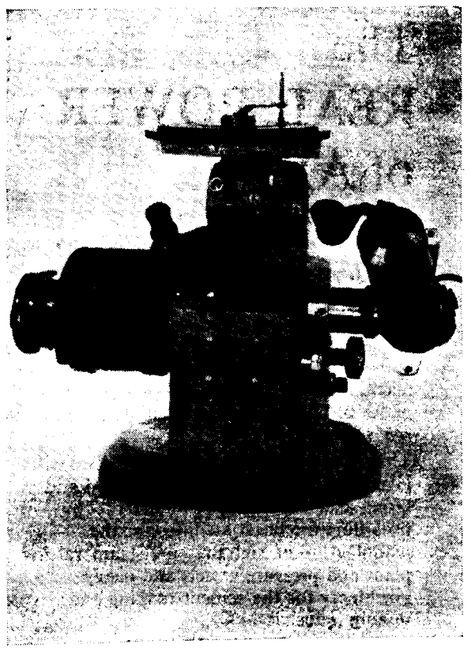

Fig. 2. Incident Light Microscope " Epityp 2 "

in size and convenient in manipulation, for series testing of micro-sections and metallographic examinations in production-control as well as in the detection of processing handicaps and in handling rejections.

Technical Data :

Convenient interchange of four plane-field Achromats with the aid of a drum-turret without need of adjusting the sliding stage. Secure footing on a circular base plate.

Illumination by 100-W Low-voltage Lamp, plane-glas reflector also in polarised light.

Observation monocular or binocular, with immersion objective, if need be. Microhardness tests with the HANEMANN Micro-Hardness Tester D 32 in place of the Plane-field Objectives.

On changing over the optical path and with the aid of K-Projectives work is possible with the Test-Strip Attachment or by photography with the " MF "—Basic Body and " MF "—Camera Attachment 6 x 6 or Miniature Camera, or " MF "—Multi-photo Attachment for three 24 x 36 photos on 6.5 x 9-plate.

Magnification : Visually : 40 to 2000x (empty magnification). With Test-strip Attachment : 40 to 1000x, Photographically : 6 x 6 : 25 : 1 to 1250 : 1 ; Substandard 12.5 : 1 to 630 : 1.

Micro-Hardness Testing Equipment " H " (Fig. 3) :

This device has been designed for determining the relative and absolute microhardness, with a quadrilateral VICKERS diamond pyramid or with a trilateral

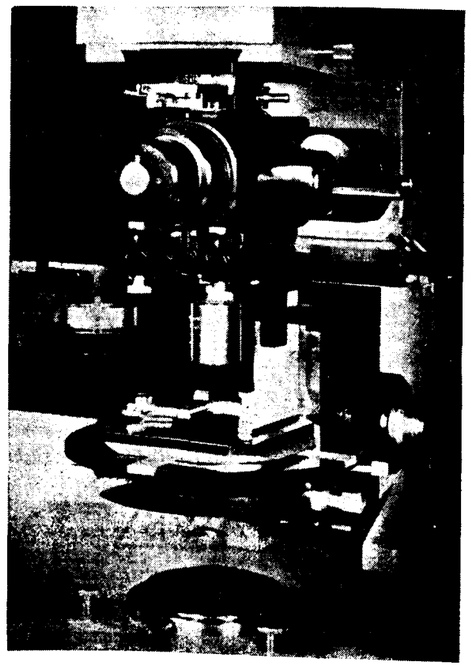

Fig. 3. Micro-hardness Tester " H "

BERKOVICH pyramid, of smallest components and for structural tests and, with the KNOOP rhombic diamond pyramid for the examination of hard and brittle substances, thin layers and of orientation influences.

Technical Data :

Joint slideway for testing device and objectives for location and measurement.

Objectives : Plane-field Achromats 10x /0.20, 25x/0.50, 63x/0.80 or Apochromat 15x/0.30 Direct addition of weights : 1.25, 2.5, 5, 10, 20, 40, 80 and 160 p ; Permitting combinations this being available for adequately fine graduations from 1.25 to 160 p. On having adjusted the indentation body relative to the objective an impact accuracy of abt. 3 microns is attainable. Provision of K 15x-Micrometer eyepiece with modified graticule facilitating the measurement of sides when employing the BERKOVICH method and of the diagonals when employing the KNOOP—method.

The employment of polarized light in microscopy is of continuously growing importance. Applied from the beginning as a method of investigation in crystallography, mineralogy, petrography, metallography and chemistry it is now also being used, and recognized in biology as well as in medicine and its associated provinces as a convenient method of recognizing and observing in a comparatively simple way any structural relations and changes in state. To permit polarized-light observations also in connection with the available types of microscopes the following Polarization Equipments were designed :

The *Polarization Equipments*, Fig. 4a and 4b, consist of the *Intermediate Tube " Pol F "*, including Filter-analyser and a filter-polarizer, which can be fitted by a quick-action device between the head of the tube carrier and the eyepiece tube. The filter-analyser—which is horizontally rotatable about 90°—is in an orientated position installed in a swing-out type of slide. As an anti-glare protection, the attenuating filter " NG 9 20 0 / 1" may be placed into the free passage of the slide. Located above the analyser slide is the tube-length correction lens with a magnification

Fig. 4a Polarization Equipment for Microscopes

Fig. 4b Polarization Equipment for Microscopes ; " Ng " and " Lg "

factor of 1.25x. The Compensators G Red I or G 1/4 *R*—which likewise are horizontally rotatable about 90°—may be inserted below the analyser. The following units may be furthermore attached, viz :

To Zeiss " L " and " N "—Stands with single condensers :

Filter polarizer in annular mount for insertion into the filter holder of the microscope ;

To " Nf "—Stand : Rotatable Filter—polarizer with clamping collar to the pancratic condenser in the condenser-turret.

The equipment with objective turret is furthermore provided with an adapter for guiding centrable objective-slides permitting a most accurate centration of objectives where axial and interference images are to be observed. Provision is for this purpose also made a centring type of rotatable specimen-stage with graduation and vernier, as well as an eyepiece with cross hairs and, if necessary, an eyepiece clamping device for the fixation of the cross hairs adjusted according to the vibration directions of the polarizers.

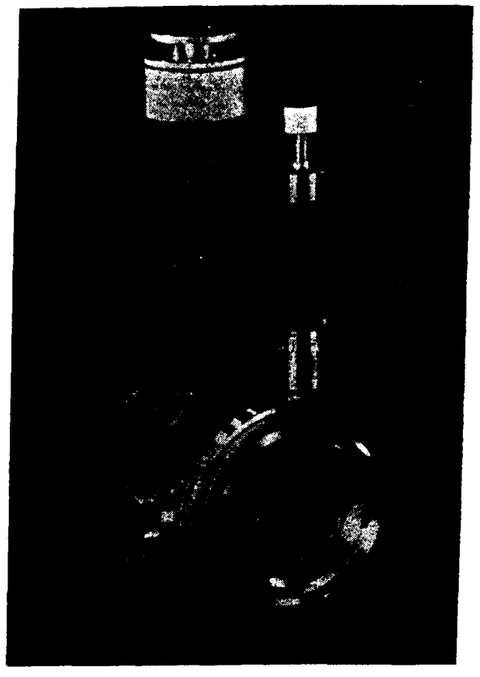

Fig. 5. Konimeter Model 10

In the province of opto-physical types of measuring instruments a line of newly developed instruments and complementary equipment will be on display.

An indispensable requirement of modern industrial and engineering activity is the preservation of health of the operators and the necessity of ensuring the quality standards of the products. A control of dust-development and of the dust-content in the air at the respective production centres is of utmost importance towards this end also applies to the continuous checking of the effectiveness of the protective measures taken in that direction.

The *KONIMETER 10* (Fig. 5) was specially designed for precision dust measurements in solving the problems of social hygiene, occupational medicine and similar dust problems in other regions. Its construction and mode of action is in accordance with the most recent findings of Dr. ROEBER in the field of Konimetry. Particular attention has been devoted to the practical requirements established by the professional committee of the " Dust and Dust-Combatting Division " of the Engineering Chamber and the Academy for Industrial Hygiene and Medico-Vocational Training for the diagnosis and combatting of silicosis, Berlin. Lichtenberg.

Technical Data :

A controllable amount of air (optionally 5, 2.5 or 1 cm^3) is sucked in through a nozzle and dust contained in that air deposited in the form of a circular speck on a suitably prepared object-disk : Quantitative dust-separation by an improved type of nozzle and pump for particles smaller than 10 microns. The object-disk is rotatable permitting 40 dust-specks to be exploited each of which can be microscopically examined and evaluated. (Magnification 200 x).

Microscope optics are adapted to the improved degree of separation : Plane-field Achromat 63x / 0.80 oo/0 ; Eyepiece with expanded field of vision. Facility of centring the dust-image. The provision of a reticule micrometer permits of subdividing the visual field for a rapid rough-evaluation. The measuring range may be extended by repeated pumping or by vacuum connection for low concentrations and by pre-konimeter for high concentrations. New arrangement of suction nozzle relative to pump and microscope affords more convenient fixture for trial photograph and microscopic observation. Weight : 1400 g ; Dimensions : 75 x 100 x 240 mm.

For the measurement of optical constants of samples monochromatic radiation is used which can be optionally separated from the spectrum of a radiating source by a Monochromator within its specific working range. For the purpose of analysis, the determination of absorption, reflexion or polarization as a function of the wavelength is of great importance. This also applies to the determination of emission distribution of a source, in which case the energy emerging from the monochromator is measured as a function of the selectable wavelength. The mode of action of a monochromator reposes on the splitting up of the radiation by means of an appropriate dispersive agent : Dispersion prisms or Diffraction grating.

Adhering to the optical construction of the former Zeiss Mirror Monochromator, a further developed design, known as the *Mirror Monochromator " SPM 1 "* (Fig. 6), will be on exhibition.

Its *technical data* are as follows :

Interchangeable prisms in WADSWORTH-arrangement, of fused quartz Si 67°-33' (prism base 77 mm), Flint-glass 60° (70 mm), LiF 82° (78 mm), NaCl 56° (60 mm), NaCl 67° (72 mm), KBr 67° (72 mm), KRS5 28° (31 mm) available for a work range from 0.21 to 40 microns. Height of prisms 50 mm. Focal length of aluminium-coated concave mirror—352 mm. Modern cylindrical housing containing all mechanical and optical units. The lid being provided with a starshaped screw, rapid access to the prism chamber is possible. The setting of the wavelength scale has been made more convenient by a forward displacement of the scale drum. The drum has a linear division permitting the setting of the wavelength according to the respective tables. Height : 320 mm ; Diameter of housing—340 mm ; Weight : abt. 20 kg.

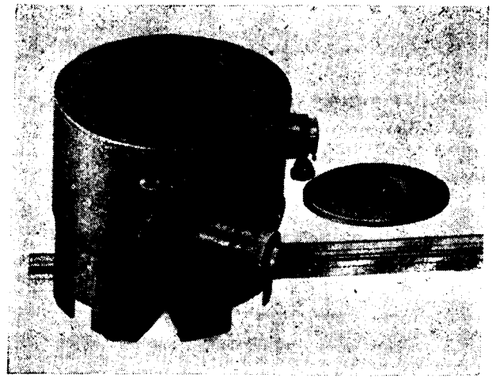

Fig. 6. Mirror Monochromator " SPM 1 "

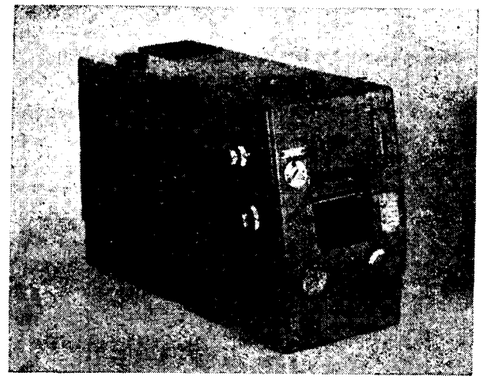

Fig. 7. Mirror Monochromator " SPM 2 "

The increased importance which is being attached to photoelectric methods of examination made it necessary to develop the *Mirror MONOCHROMATOR " SPM 2 "* (Fig. 7), an instrument satisfying the most exacting demands in respect of applicability, performance and operating comfort. Its *technical data* are as follows :

Production of monochromatic radiation in wavelength region from 0.193 to 40 microns, using interchangeable prisms and diffraction grating. The radiation, which is to be spectrally split up, twice traverses the WADSWORTH-mounted prisms. By means of a aluminium-coated extra-axial parabolic mirror of 400 mm. focal length, a stigmatic image of the entrance-slit is reflected on to the curved exit-slit via the fully utilizable slit-height of 20 mm. Readings of the wavelengths are taken from a projected scale via

the 50 mm-high prisms of fused quartz Si 67° 33' (prism base 77 mm), Flint glass 60° (70 mm) LiF 82° (78 mm), NaCl 56° (60 mm), KBr 67° (72 mm), KRS5 28° (31 mm). Deviations in the wavelength indication due to temperature influences and prism-tolerances are being eliminated by scale-displacement. A linear scale is available when additional dispersion prisms (as CsJ, f.i.) for extension of the range up to 50 microns are needed and when the diffraction grating is to be used. Precision Diffraction Grating: plane, 650 lines per mm, divided grating surface 70 x 60 mm, Blaze-wave length 5700 Å. The entrance and exit slits are coupled and adjustable up to width of 1.5 mm by a logarithmically divided drum. The arrangement of radiation sources and receivers is effected on oppositely-located panels of the housing, or an optical bench which is aligned with the entrance and exit slit. Provisions for connecting an airconditioning plant are made. Dimensions: 690 x 330 x 420 mm ; Weight : abt. 30 kg.

Another instrument on exhibition is the Zeiss Three-Prism-Spectrograph with glass optics and the focal lengths of 12 cm and 27 cm. It is designed for use in organo-chemical industries as a spectral instrument of high relative aperture for Raman-analytical investigations of organic compounds or of fluorescence and flame spectra as well as of plasma radiations and other faint or momentary light phenomena. In conjunction with the 130 cm. Camera the Three-Prism Spectrograph is available for specific problems of the elementary spectral analysis of inorganic substances, as for instance for the photography of highly complex emission spectra of rare earths and their spectral components, furthermore, of hard and sinter metals on tungsten-basis, of ceramic products on circonium or titanium-oxide basis, as well as, for the spectral resolution of certain molecule-bands and the concomitant isotopy-differentiations. In order also to attend to additional spectro-analytical problems such as require a survey over the entire visible region, an *Image-Flattening Device* (Fig. 8) for the Auto-Collimation Camera 130 of the Three-Prism Spectrograph was developed. Its technical details as the following :

It extends the range of definition of spectra over the entire 18 cm-length of the plate format, thus rendering analytically evaluable also those spectral lines that lie at the edge of the plate.

The visible spectrum with border regions of 3700 Å is obtainable at fine definition in five partial regions linking up with one another of high dispersion. (Without the Image-Flattening Device, three times the number of part spectrograms would be required for a well-defined total spectrum). The flattening of image is achieved by a negative cylinder lens

Fig. 8. Image Flattening Device

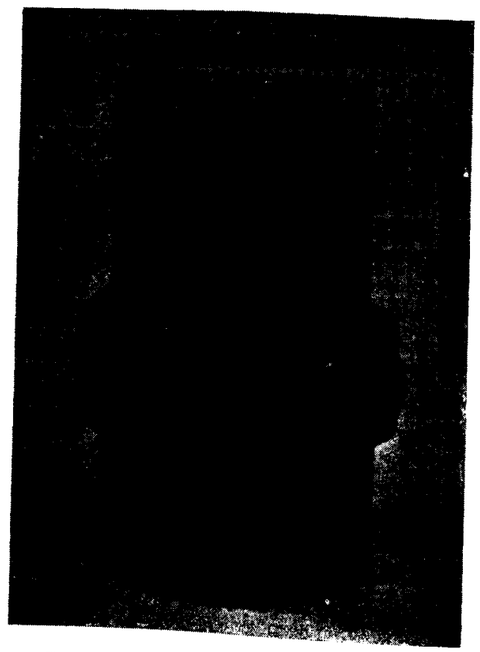

Fig. 9. High-Vacuum Oil Diffusion Pump "HVPO-2000"

located immediately in front of the photo plate. The device is easily attachable where the cassette was located and takes over the function of the cassette carrier.

The applicability the *Universal Spectrophotometer "VSU 1"* has been considerably extended by the new design of the Mirror Monochromator "SPM 1" and having been in the meantime equipped with a new *Cell-Changing Device*. It is the purpose of the latter quickly and conveniently to effect the interchange of the photocells, which becomes necessary at a wave length of about 630 m/u. This exchange of cells is possible in one single manipulation without need of opening the housing of the Measuring device A. Red and blue-sensitive cells are fastened to a common-carrier which, by means of a pin passing through the side of the Housing, can be shifted in horizontal direction behind the light entrance.

The Photoelectric Supplementary "ELPHO" for the PULFRICH Photometer affords increased measuring speed and greater reliability of the measuring results whilst ensuring the universal applicability of the Pulrich Photometer for the entire province of colorimetry. In order to be able to use any of the testing vessels supplied with this instrument and which differ by their construction and their stratum thicknesses, and the employment of which is determined by the respective extinction and quantities of substance, the "ELPHO" has been equipped with various supplementary optics for C-cells, small and micro-cells. New *supplementary optics* were now added to these thus permitting the use also of *absorption tubes of 20 and 50 cm. stratum thicknesses*, as well as of micro-absorption tubes of 10 and 20 cm. stratum thicknesses.

In vacuum engineering High-vacuum Oil Diffusion Pumps of high suction speeds and at the same time with efficient final vacuum are used both for scientific and industrial purposes. This applies, for instance, to high-vacuum plants for depositing, annealing, sintering, casting, smelting, de-gassing, impregnating and dry-freezing, as also for the employment with mass separators and accelerators in nuclear engineering.

High-vacuum pump stands for metallurgical, chemical, pharmaceutical, opto-scientific and electro-technical industries, furthermore require to be suitable for the evacuation of the conventionally large containers.

In addition to the *high-vacuum oil diffusion pumps* "HVPO-120" and "HVPO-500" with evacuation rates of 120 l sec^{-1} and 500 l sec^{-1}, respectively, made by VEB Carl Zeiss JENA during the last few years, a further model, viz, the "*HVPO-2000*" (Fig. 9) with a still greater rate of evacuation has been developed. Its *technical data* are the follwing :

The "HVPO-2000" is triple-stepped and water-cooled. The attainable final vacuum is below 10^{-6} Torr. Propellents used are high-vacuum mineral or silicon oils. Owing to the propellant being positively guided in

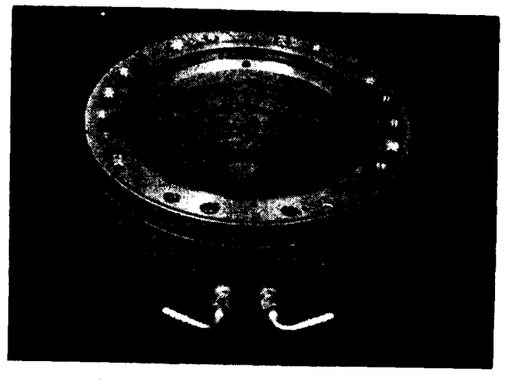

Fig. 10. Oil-Vapour Baffle "DSO-250w"

Fig. 11. Pre-vacuum Indicator Heads "Ak-2/B" and "Ak-2/C"

the boiling chamber of the high-vacuum pump, effective de-gassing and fractionization as well as a continuous cleaning of the

propellant is ensured. Rate of evacuation is between 10^{-4} and 10^{-6} Torr > 2000 l sec^{-1}. Pre-vacuum required is 0.2 Torr, Propellant charge 1500 cm^3, Operating voltage 220 V, Heating power 2000 W, Suction port: on the high-vacuum side 250 mm O, on the pre-vacuum side 50 mm O, high-vacuum connection 250 X 375 according to ZN 2131, Prevacuum connection 50 X 120 according to ZN 2131; Total height 600 mm., Weight: 65 kg.

The water-cooled Oil-Vapour Baffle "DSO-250w" (Fig. 10) is intended to produce a high-vacuum which is especially free from propellant-vapour. The baffle is mounted between the High-Vacuum Oil Diffusion Pump and the check valve or the recipient, respectively. It reduces the backflow of the propellant by more than 10 000-fold. A connection for attaching high-vacuum measuring instruments is provided for at the side of the oil vapour baffle. The dimensions of the baffle are: Cross section of suction port 250 mm O, outside diameter 375 mm, height 120 mm and weight 17 kg.

The *Pre-Vacuum Indicator Head* "Ak-2/A-C" (Fig. 11), is a supplementary unit to the High-Vacuum Meter "HVM-6" and serves for checking the pressure within the range from 1.5 Torr to 6.10^{-2} Torr. The measuring principle reposes on gas ionization. It is especially efficient for the supervision of the pre-vacuum pressure in high-vacuum diffusion pumps as well as for checking the pressure in the recipient before the high-vacuum pump is connected and for pressure-dependent switching operations. The instrument is marked by its simple

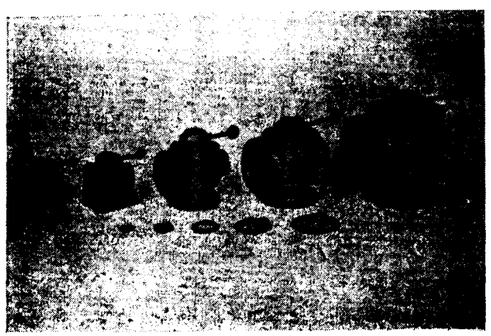

Fig. 12. Quick-action Valve "EV 50"
Fig. 13. Quick-action Valve "EV 65"
Fig. 14. Quick-action Valve "EV 100"

construction, convenient connecting facility, and by being little susceptible to dust etc. and entirely immune against air-ingress.

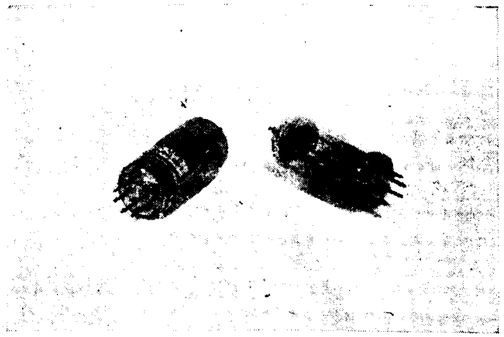

Fig. 16. Miniature Photocell "DSV 1"

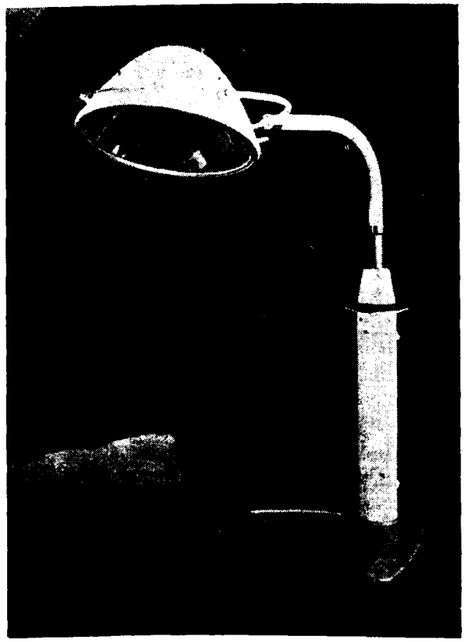

Fig. 17. Operating Room Illuminant 600

By building efficient high-vacuum plants, VEB Carl Zeiss JENA intend to promote vacuum-technical procedures in science and industry and to provide users with *typified high-vacuum units* to facilitate the

elaboration of suitable working methods. On the occasion of the Technical Leipzig Fair, new *quick-action valves* and *magnetic quick-action valves* will be introduced in addition to the high-vacuum units now available.

The Quick-Action Valves "EV20", "EV32", "EV50" "EV65" and EV100" (Figs. 12, 13, 14) are of the rapid-closing type which can be opened or closed by the simple switching of a lever. The flange connections for inlet and outlet lie at an angle of 90° to one another. Another connection is available for the attachment of meters. All valves open against atmospheric pressure and hold tight in both directions. The permissible leakage is smaller than 1×10^{-5} Torr 1/sec. The *technical data* are as follows:

Quick-action Valves	EV20	EV32	EV50	EV65	EV100
Nominal width	20	32	50	65	100
Diameter of suction pipe	20	32	50	70	100 mm
Flange connection		2×NW32	2×NW50	2×NW65	2×NW100
TGL 26–1004	3×NW20	1×NW20	1×NW20	1×NW20	1×NW20
Weight	2.9	5.5	6.5	8.5	19.5 kg
Dimensions	120×70 ×165	130×90 ×170	190×120 ×230	210×140 ×260	270×190 mm ×350

The Magnetic Quick-action Valves EVm20, EVm32, (Fig. 15) are opened by single-phase a. c.-magnets and closed by spring action. In the event of current failure the magnetic valves close automatically thus preventing undesirable air-ingress into the vacuum chambers. Flange connections lie at an angle of 90° to one another. Provision is made for the attachment of meters. The valves open against atmospheric pressure and are tight in either direction. The permissible leakage is smaller than 1×10^{-5} Torr 1/sec. The flange connections of the magnetic type of quick-action valves agree with those of the angle valves. Valves of the same nominal width are interchangeable one for the other.

Technical Data:

Magnetic Quick-action valves	EVm20	EVm32	
Diameter of suction pipe	20	32	mm
Flange connetions TGL 26-1004	3 X NW20	2 X NW32 1 X NW20	
Magnet	220 50	220 50	V Cycles
Traction current	5	9	A
Retaining current	0.35	0.5	A
Weight	4.6	7	kp
Dimensions	205 X 70X 200	205 X 90X 215	mm

The large number of series-produced photoelectric elements of all types which are of special significance for automatic regulating and controlling processes has been extended by the following briefly described new developments, viz:

The Miniature Photocell "DVS1" (Fig. 16)

A standard type with Cesium-Antimon photocathode, used with advantage in the wavelength region from 300 to 650 nm. The maximum sensitivity (according to DIN 44021, sheet 2) lies between 350 and 450 nm. The form of the photocell is in accordance with the DIN 44023-specification, with the nominal size of the window of 11 X 14 mm^2 basing on the rated size 38. The outer dimensions are in accordance with DIN 41537, sheet 1, and the dimensions of the 7-pin socket with DIN 41537, sheet 2. The operating voltage $U_b < 100$ V is guaranteed by: Sensitivity of photocathode S<.30 microns A/lm, Dark-current $I_o <= 9.10^{-10}$ A.

The *Cooling Device for Photomultipliers* of the "M12F"-series with a piston diameter of 36 mm serves for the reduction of the thermic emission of the photocathode and thus for the improvement of the Signal-to-Noise-Ratio. It consists of an aluminium housing which holds a Dewar-vessel into which is inserted the CO_2-snow-cooling cartridge which closely embraces the photomultiplier. 20 minutes after the cooling cartridge has been inserted, the photomultiplier is perfectly ready for work and ensures cooling

for a period of about three hours. The cooling device is attachable to the socket of the photomultiplier by means of a screw connection. Furthermore installed in the housing is a magnetic screening unit. Dimensions : maximum diameter = 87.5 mm. With the cooling device mounted to it the length of the photomultiplier increases by a maximum of 22 mm.

Photomultiplier " M 12 FS 150"

The *magnetic screening units* for photomultipliers guarding against electro-magnetic interference fields consist of a metal-cylinder cemented into a mount with magnetic screening properties and are fitted to the socket of the respective types either by screw or clamping connections, viz : by screw connection to the models M12FS35 and M12FQS35, and by clamping connection to the models K 14FS50, M12FS60, M12FS100 and M12FS150.

Dimensions :

Screening	35	maximum diameter	47	mm
Screening	50	,, ,,	59	mm
Screening	60	,, ,,	71.2	mm
Screening	100	,, ,,	112.6	mm
Screening	150	,, ,,	168.9	mm

The length does not exceed that of the respective *photomultiplier*.

Measuring Head for Photomultipliers : After insertion of the photomultiplier the measuring head permits of making connection to the stabilized high-tension source as well as of attaching or installing measuring instruments. The Measuring Head contains the photomultiplier (M12FS35 or M12FQS35), the magnetic screening, the mount of the photomultiplier, the work or measuring resistance, as well as two cable connections for the measuring and high-tension cable. The measuring head may be supplied without photomultiplier if so requested. The work-resistance and the first step-resistance controlling the signal-to-noise-ratio are interchangeable. The operation of the Measuring Head calls for a stabilized high-tension of maximum 2000 V, which may be taken from High-Tension Mains Unit " Phol " (cf. Zeiss brochure No. 40-G605-1). Dimensions : Diameter 58 mm, Length 195 mm, Cable-length optional.

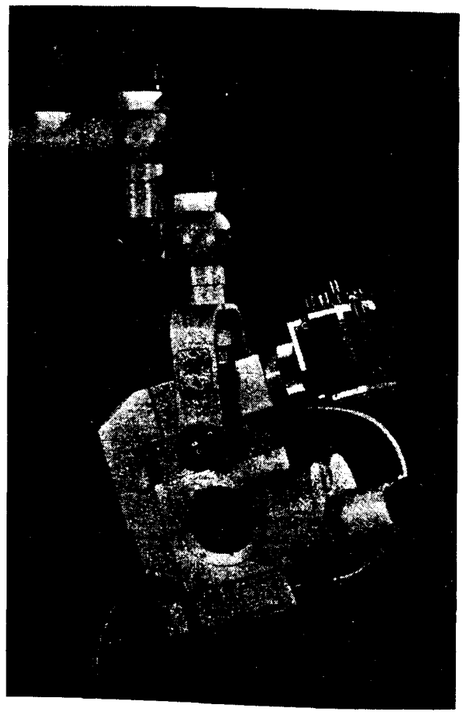

Fig. 18. Photo-Attachment for Surgical Microscope II and Colposcope III

Medical, Ophthalmological Instruments and Ophthalmic Lenses :

In this branch, the following new items will be on exhibition at the Leipzig Fair :

The Operating Room Illuminant 600 (Fig. 17) is mounted on a mobile stand easily movable on noise-damping casters. It is especially suitable both for high but also for particularly low operating rooms in Eye-Ear-Nose and Throat as well as in Dental Clinics and Ambulatoriums. Its salient features may be summarised as follows :

Aluminium Reflector 600 mm effective diameter, of high reflecting capacity and aperture, Central luminosity with conventional type of filament lamp 100/220≈ 13500 l X at a working distance of 0.9 metre ;

Uniformly illuminated field, minimized cast-shadow effect, no glare, negligible heat radiation and daylight effect. Protection of reflector by a sealed, laminated, non-splintering glass front.

Convenient adjustability of the illuminant within a height range of 1600 to 2000 mm (figured from the floor). Counterweight runs norselss in the instrument column. Illuminant may be swung about the column by about ± 40°. The body of the illuminant is gimbal-mounted in a forkbearing and tiltable in all directions. Tilting in the direction of the column up to 15° ; in all other directions the movement is limited to 90° by means of arresting stops. The position of the axis of rotation relative to the center of gravity has been arranged in a way that permits all adjustments to be made without extra clamping operations.

Photo-Attachment (Fig. 18) for use in conjunction with the Surgical Microscope II and the Colposcope III is intended for the documentation of medical findings. Perfect attachment and fixation is ensured by three-point seating ; no subsequent adjustments ; Critical focussing with the aid of a circular graticule in the right-hand eyepiece which coincides with the visual field and the camera film plane. The Photo-Attachment can be used for 35 mm-cameras CONTAX, EXACTA, PRACTICA for format

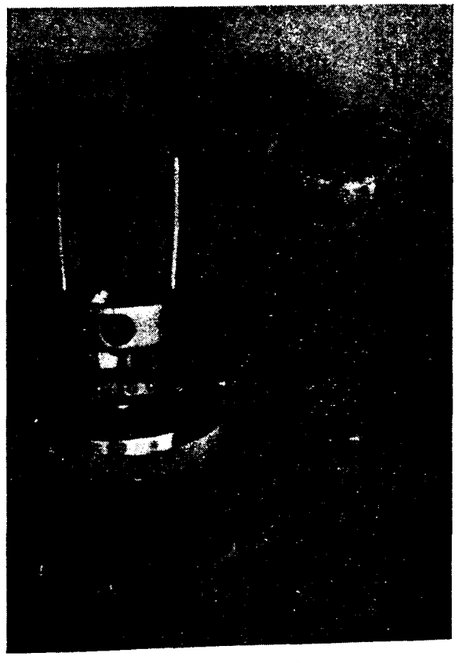

Fig. 19. Schiotz-Standard-Tonometer

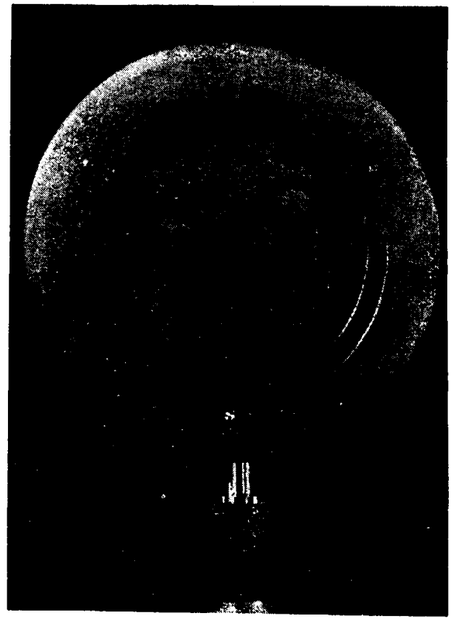

Fig. 20. Screen-type Visual Balance Tester

24 X 36 mm, magnification scale $B = 1.28$, invariable diaphragm ; At an approximate 2.5 mm depth of focus any focusing errors are practically impossible. Supplementary illumination of the object field when exposing the film by annular flash tubes with 200 Wsec flash energy. When using AGFA-Color Reversal Film 16°/10 DIN or fluorescence film, flash energies of 200 Wsec and 50 Wsec will be sufficient to yield well-exposed photographs. The photographic optics of the Photo-Attachment produce pictures of most excellent quality.

The measurement of the intraocular pressure in the human eye is of particular importance for the diagnosis and the progress of the treatment in case of glaucoma.

The new *Schiotz-Standard-Tonometer*, as suggested by Dr. COMBERG, (Fig. 19) has been designed in strict conformity with the Specifications No. 5 of 13th Oct. 1959 of the "Committee on Standardisation of Tonometers". The new Zeiss-Tonometer is provided with jewel bearings considerably reducing the source of friction of the movable parts. A novel way of fixture ensures reliable and safe handling when examining and when putting the instrument aside. The simple interchangeability of the contactor considerably facilitates cleaning. The equipment of the Tonometer includes an extra contactor, supplementary weights of 7.5, 10 and 15 g and a container in which the instrument is stored in an upright position.

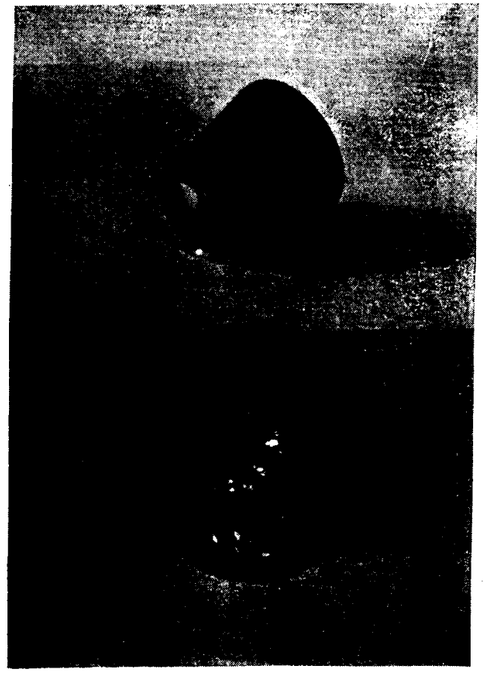

Fig. 21. Zeiss Three-Mirror Contact Lens

For testing the refractive and muscular balance according to the TURVILLE Infinity Balance Method (TIB), the *Screen-Type Visual Balance Tester* (Fig. 20) has been developed. The instrument presents to both separate sight-testing marks. Separation of these marks is effected in a novel way suggested by UEBERSCHAAR, Physicist, according to the screening method employed in some stereo-film procedures, in that the test marks are resolved and separated by mosaic screen installed in front of them. The advantage of this method lies in the fact that the separator is firmly connected with the test-signs and that it is situated close to the plane of the test-sign. It will not therefore be possible to simulate esophoria resulting from accommodative convergency, and there js no need (as is the case when separating by polarization) of exactly aligning any auxiliary contrivances of any kind whatever. Binocular vision is effected unhampered under practically normal conditions.

The new Zeiss Three-Mirror Contact Lens (Fig. 21) corresponds in its basic design to the three-mirror contact lens suggested by GOLDMANN. It represents a means for observing the central and peripheral parts of the fundus (retina etc.) as well as of the anterior chamber angle, with the stereomicroscope of the Slit. Lamp.

The Three-Mirror Contact Lens is cone-shaped contact lens 2.5 cm long, which can be attached to the eye with a corneal and scleral portion and which, by means of a plane glass surface, borders on air.

Fig. 22. Corneal Shells

The outstanding feature of the Three-Mirror Contact Lens—which weighs 22 g—is the excellent, clear image it conveys and its high resistance to scratching.

To complete the list of new developments exhibited by VEB Carl Zeiss JENA at the 1962 Leipzig Fair, mention may be made of new spectacle lenses displayed for the first time to oculists and opticians, viz :

Corneal shells (Fig. 22) contacting only the cornea of the eye and possessing no scleral portion as a carrier-agent. They are made of acid-resistant and scratch-proof silicate glass and are not subject to deformations, as experienced with plastic lenses, for instance.

Cataract Lens with non-spherical surface : This lens has been designed for the correction of aphakic eyes. The non-spherical lens which has a diameter of 30 mm is fused into a carrier-lens 54 mm in diameter.

The Trifocal Lens (Fig. 23) affords perfect vision into the distance, as well as into medium distance and reading distance. The reading and medium-distance portions are fused-in.

In the *Bifocal Lens* the reading portion is fused-in with a straight separating line.

Fig. 23. Trifocal Lens

The *Anti-Glare Lens* with polarization eliminates the effects of dazzling reflexions and thus serves to increase the safety in traffic.

Universal Research Microscope Nu

By

Joachim Bergner, Eberhard Gelbcke and Ludwig Otto

INVESTIGATION methods in modern microscopy are continuously increasing in extent and versatility and therefore place ever more exacting demands on instruments manufacture with regard to universality, range of application and convenience of operation. The universal "Nu" Research Microscope (Fig. 1), conceived and designed by BRUNO GERSTENBERGER, Optical Engineer, and developed by the engineers JURSCH, HERR and SEBASTIAN must be considered a top-flight product of opto-scientific instrument manufacture.

The basic consideration on which the design of this Universal Research Microscope has been developed is the need for employing many different investigating methods for the same specimens. This means that the instrument components must be widely interchangeable whilst simultaneously maintaining the optical and mechanical adjustment. The principal prerequisite for the successful application of a large number of observation methods is the availability of an adequate number of suitable light sources ensuring perfect observation or photography with everyone of the methods used. The "Nu—" Microscope provides the optional application of four light sources (Fig. 2) i.e. of the 6 V 30 W lamp, 12 V 100 W lamp, Xenon lamp XBO 100, and the high-pressure mercury lamp HBO 50. An eleven-step illumination control permits very accurate setting of the brightness of the microscopic image. As this controlling device does not produce any colour changes it is possible to use exposure periods, especially

Fig. 1 Universal Research Microscope "Nu"

Fig. 2 Lamp arrangement on working table and stand

On table: left– lamp 12V 100W

right– high pressure Xenon lamp XBO 100

On stand: filament lamp 6V 30W

in colour-film photomicrography, which would otherwise not be possible.

With the above described illumination equipment the following observation methods are available:

In Transmitted Light:

Bright field, dark field, phase-contrast, fluorescent, polarization.

In Incident Light:

Bright field, dark field, phase-contrast, fluorescent, polarization, interference, hardness testing.

In Combined Incident Light and Transmitted Light:

Transmitted light		Incident light
–bright field	combined with	–bright field,
–polarization		–polarised,
–fluorescent		–fluorescent,
–dark field		–dark field,
		–phase contrast

The alternate application of the above investigation methods on the same specimen is achieved by simple universal interchangeability of important units. In addition to the generally interchangeable parts, such as filters, objectives, eyepieces, condensers, the following are also interchangeable on the "Nu": condenser support, stage support, specimen stages, objective changing devices, tubes, camera attachments and lamps.

The "Nu" occupies a special position amongst the top instruments in the world because of its two pancratic systems, i.e. lens systems of controllable and reproducibly variable focal length. A pancratic illumination system ensures optimum use of the illuminating light beam in transmitted light while at the same time ensuring the KOHLER principle of illumination in any position. A pancratic eyepiece system saves the user the irksome and time-wasting changing of eyepieces during observation. By adjustment, series of magnifications can be set within the limits of useful magnification after ABBE, but the pancratic eyepiece also permits values below or above these limits in instances where the investigation method or the specimen requires it. The range of useful magnification is between 50× and 1300×, the range of overall magnification from 44× to 2500×. If required the pancratic eyepiece can be rendered inoperative.

Usually observation is carried out binocularly at a viewing angle of 20° which permits a natural and relaxed position of body and head. Monocular tubes are only used in polarization microscopy, in measuring the length of the specimens and sometimes in fluorescence microscopy. An AMICI-BERTRAND lens is used for centering the annular diaphragm for phase-contrast; the lens is built into the attachment piece of the observation tubes. It is focusable and of the swing-out type.

The "Nu" being equipped with objectives of the plane-field achromatic both for visual as well as photographic observation. For both these methods the "Nu" is supplied with an extensive set of light filters for incident and transmitted light. These filter sets, mechanical and optical interchangeable parts, as well as adjusting aids, special tools and measuring instruments are accommodated in accessory drawers especially provided for them in the right side of the working table. The left side contains the electrical installations and the power supply units for the built-in lamps.

The Photomicrographic Equipment is part of the well known and extensive "MF"-range. The design is arranged in such a manner that the object image visible in the binocular tube is conjugate with the plane of the negative. An optional interchangeable plate with format outlines serves at the same time for checking this conjugation and for adapting the viewing tube to any possible visual defects. The exposure times can best be determined by means of a barrier layer cell at a position conjugate to the image, and the photo-current of which can be measured by means of a light-mark Galvanometer. The measured value is calibrated with reference to the exposure times, depending upon the film emulsion used and the developing process employed. Small format sizes viz., 24×36 or 24×24mm as well as medium size 6×6cm can be used. For the latter size, plates sheet films and roll films can be used, whilst for the small image size standard cine film is used.

The *Zeiss Automatic Exposure System* is available for use also with the "Nu" but in this instance, same as when using the "MF"-basic unit "Pollum" the image conjugation with the binocular tube is no longer possible, so that focusing must be effected via the focusing telescope of the "MF"-basic body.

Fig. 3 "Nu" equipped for transmitted light

To explain the specific method of working with the "Nu"–Universal Research Microscope, details are given below of the *assembly and equipment* of the microscope for the various investigating methods :

ILLUMINATION IN TRANSMITTED LIGHT (Fig. 3)

Bright field

Normally the 6V 30W lamp is used for illumination and the 12V 100W lamp for photography. For photographic work the pancratic illuminating system which is of help for visual observation should be replaced by a single condenser. The even luminous coverage of the objective by adjusting the aperture stop or the pancratic system is controllable with the aid of the built-in AMICI-BERTRAND lens. The magnification used can be ascertained by multiplying the scale figure of the objective with the magnification factor of the pancratic eyepiece; tube factors need not be taken into consideration.

Dark field work

For illumination the 12V 100W lamp should normally be used. For carrying out observations with objectives of an aperture of 0.65 the cardioid condenser is used in conjunction with the pancratic illuminating system; with lower power objectives the dissecting change-over condenser in centerable support can also be used for illumination.

Phase contrast work

For illumination one of the two filament lamps can be used. The aplanatic condenser 1.4 with pancratic illuminating system and centerable annular diaphragm fixed to it can be used as a phase contrast condenser. The projection of the annular stop-image at the size required for the objective used in any particular case is effected by a corresponding setting of the pancratic illuminating system, and the centering of the images of the annular stop relative to the phase rings of the objective, by means of the adjustable annular stop. These adjustments can be checked by swinging-in the AMICI–BERTRAND lens built into the tube attachment. For phase contrast work with the "Nu"–microscope Plane-field Achromats "Phv" are supplied.

WORK IN POLARIZED LIGHT (Fig. 4)

For illumination purposes either the 12V 100W lamp with day-light filter or the "XBO 100" are used. For

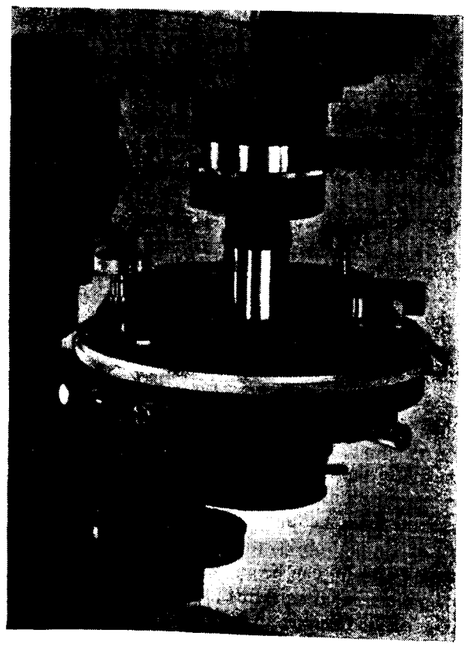

Fig. 4 Equipment for polarization microscopy

simplest polarized optical work, especially for investigating whether a specimen is anisotropic or isotropic, the filter analyser fitted in the revolving nosepiece is interposed. Into the filter holder of the respective condenser a mounted polarizing filter is inserted and turned until the object-free filed shows maximum darkness. The polarization field thus produced will generally be neither homogeneous nor completely extinct but will at any rate be sufficient for ascertaining any existing anisotropy in the specimen. The advantage of the device consists in permitting the rapid changeover from one method of observation to the other without any kind of re-assembly of the instrument. The device also permits investigation by phase contrast in polarized light, thus for instance, the determinatlon of refractive indices according to the emmerging method.

THE "Nu" USED AS A POLARIZATION MICROSCOPE

The more accurate qualitative and especially quantitative analyses require a more elaborate effort in optical and mechanical respects. It takes but a few manipulations to convert the "Nu" into a highly efficient polarization microscope satisfying exacting demands. To this end the following units require to be added to the basic equipment, viz. :

(a) The three-lens Polarization Condenser with swing-out type of front lens and auxiliary diffusing lens for the luminous coverage of large object fields provided with swing-out rotatable polarizer. When in its zero position the polarizer's direction of vibration runs North-South.

(b) The ball-bearing seated Specimen Stage M with 360° graduation and vernier (reading to 1/10°), with locking and repetition clamp which is adjustable in any stage-position and which permits of stopping the stage rotation after each 45° interval. A stage-support M, centered at the factory, is required for the specimen stage M. Also an object traverser (28×48) with graduation and vernier (Fig. 5) may be attached.

(c) The Intermediate Tube "Pol", to which may be fitted centerable objective slides and which is provided with a built-in rotatable and cut-out type of analyser as well as with receptors for Compensator Plates Red I and quarter-wave plates, and with wedge or rotatory compensators. The tube-recess for wedge and rotatory compensators inclines at a 45° angle relative to the vibration direction of the analyser in SE–NW–direction and may be protected by a dust-collar.

(d) The Plane-Field Achromats "Pol" which are specially selected for polarization-microscopy and which may be introduced into the Polarization Tube "Pol" by means of centering types of objective slides.

(e) The straight monocular Polarization Tube equipped with BERTRAND-lens and the tube iris diaphragm for isolating small crystals for indirect observation.

(f) The Plane-Field Eyepieces "Pol" with 90° cross-wires lying parallel to the vibration direction of the polarizer.

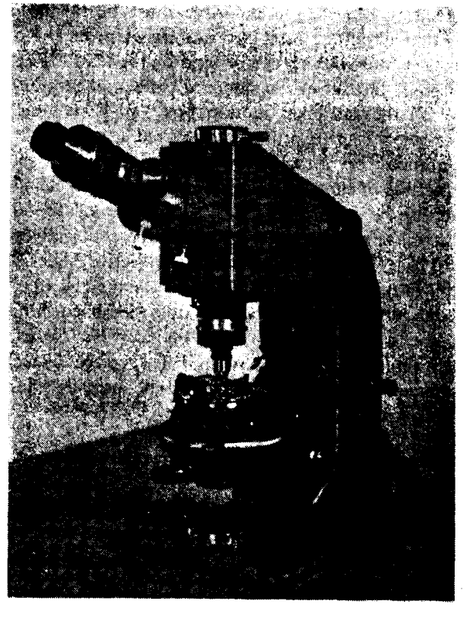

Fig. 5 Equipment for polarization microscopy with Fedorov Universal Stage

This equipment is provided especially for work in the direct optical path. When working with the pancratic beam it should be noted that because of the built-in beam-splitter the analyser must always remain in the optical path at its zero position. When investigating

pleochroic objects the polarizer must be taken out of the optical path. Also our four-axis Universal Rotary Stage (Fedorov-type) can be used on the "Nu". For this purpose, instead of the standard condenser motion box "W 3", the shortened motion box "W 4" is attached. The object stage can then be lowered leaving sufficient clearance for attaching the U-stage. The special objectives of the U-stage computed for the "Polmi A" can also be used on the "Nu". Because of the different image positions in both stands these objectives are used on the "Nu" with special objective slides with built-in tube-length correction lens (factor 1.8×). The wedge and rotatory compensators supplied for the "Polmi A" can also be used on the "Nu". Attachment units for fixing the WRIGHT eyepiece as well as a binocular polarising tube, will be provided for in due course.

WORK IN FLUORESCENT LIGHT

As exciting light source the high pressure mercury vapour lamp "HBO 50" is used, which, in its housing, is to take the place of the 6V 30W lamp. The pancratic illuminating system is to be replaced by a conventional type of condenser of as high an aperture as possible.

The filters for the exciter light are placed into the filter holder in the base of the microscope, the eyepiece barrier-filter are installed in the revolving nosepiece. Whether the pancratic eyepiece and the binocular tube can be used depends on the luminous power of the specimen.

INCIDENT-LIGHT ILLUMINATION (Fig.6)

For observation and photomicrography of surfaces of opaque specimens (metals, ores, rock, coal, etc.) the "Nu" microscope can be equipped with an incident light illuminating device. By suitable introduction of deflecting components in the optical path, light from the attached lamp can also be used for incident light investigations. The objectives used in that case are Plane-field Achromats the magnifications of which are graduated same as the transmitted light objectives. The difference in the two objective series consists in the incident-light objectives being corrected for use without a cover glass and being accordingly engraved with cover glass thickness "0". The transmitted light objectives are marked "0.17" and systems unsusceptible to cover glasses and therefore suitable for incident and transmitted light, are engraved "–". The incident-light condenser, which may be attached to the stand instead of the revolving nosepiece, is designed for the application of the KOHLER principle of illumination. The

Fig. 6 "Nu" equipped for incident light with lamp "HBO 50" and camera Attachment MF "Pollum"

condenser motion box is taken off and the stage support placed as low as called for by the specimen. For investigations in incident light we recommend the use of the sliding stage H5, which is specially built for this purpose.

The following investigation methods can be used :

Working in bright field :

Usually the 12 V 100 W lamp can be recommended as light source, the light from which is directed by the plane glass reflector in the incident-light condenser on to the specimen. Observation can be carried out with or without the pancratic eyepiece.

Working in dark field :

For the light source the use is recommended of the 12 V 100 W lamp and also of the " XBO 100 ". Its light is directed by an annular mirror and the annular mirror-condenser on to the specimen. In order to give the illuminating beam the requisite annular cross-section a mirror staircase is brought into the optical path instead of the field lens used in bright field work. Both components are fixed on the same slide on the

side of the incident light condenser facing the stand. Use of the pancratic eyepiece depends on the reflecting properties of the specimen.

Phase-contrast work :

As a light source the 12 V 100 W lamp or the HBO 50 are recommended illumination must be effected via the plane glass reflector. After interposing the annular phase diaphragm and the auxiliary lens matching the objective, as well as after introducing the phase plate, centering is carried out by means of the built-in AMICI-BERTRAND lens with the pancratic eyepiece taken out of the beam. Observation can then be carried out with the pancratic eyepiece.

Working in polarised light (Fig 7).

As light source either the 12 V 100 W lamp with day light filter or the " XBO 100 " are used. As reflecting component the ERBEK Compensation Prism is used for preference as only this leaves the polarization condition of the incident light unchanged. The optionally insertable glass plate produces on the other hand slightly elliptical polarization.

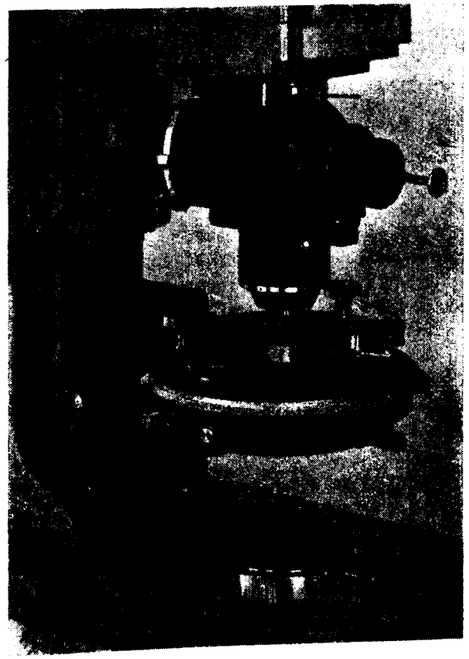

Fig. 7 Polarization equipment for incident light

Part of the incident light polarizing equipment is firmly fixed to the incident light condenser. The polarizer is attached on to the bright-dark field slide and set so that the index of the lever points exactly to 0. For reflection measurement the polarizer can be turned through—45°. The rotatable analyser lies in a slide which can be moved in and out closely underneath the tube system ; in the zero position its vibration direction is East to West. Underneath the analyser compensator Red I and /4 can be arranged. In the free part of the slide it is possible to insert an absorbing filter NG 9/1 which compensates for the great difference in brightness between observation with on polarizer or cross polarizers. For photomicrography the filter must be removed.

Also for incident-light investigation the Plane-field Achromats " Pol " are fitted in low-strain mounts.

The " MF "-basic unit " Pollum " with exposure-meter unit is recommended for photomicrography in polarized light. The measuring instrument (Galvanometer) should have a sensitivity of approx. 10^{-10} to 10^{-9} A/scale-interval.

WORKING IN FLUORESCENT LIGHT :

For this purpose the mercury vapour lamp " HBO 50 " must be used with filters which transmit the required exciter wavelengths. The illumination should preferably be produced in the bright field optical path via a plane glass reflector. The eyepiece barrier filters are mounted in slides and are inserted into the incident-light condenser. In fluorescent microscopy the pancratic eyepiece is used in exceptional cases only.

Working with the Micro-Hardness Tester (Fig. 8) :

As light source usually the 12 V 100 W lamp will be used and as illumination component the plane glass reflector should be inserted.

For the determination of micro-hardness a Micro-Hardness Tester " H " may be attached to the " Nu". This is inserted into the incident light condenser in place of the objective slide. On a common slide an incident-light objective aad an indentation body are fixed. Both may be centered relative to one another so that the test indentation lies in the centre of the visual field. Observation can be carried out in bright or dark field, but also the application of phase contrast illusmination will be of advantage when it is required to ascertain the directional dependence of a

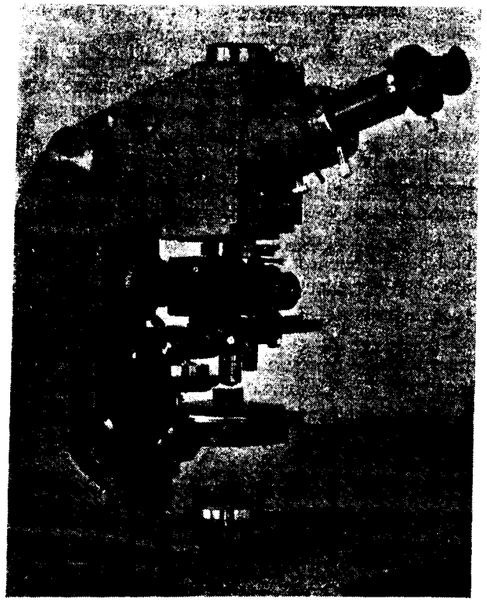

Fig. 8 "Nu" with Micro-Hardness Tester

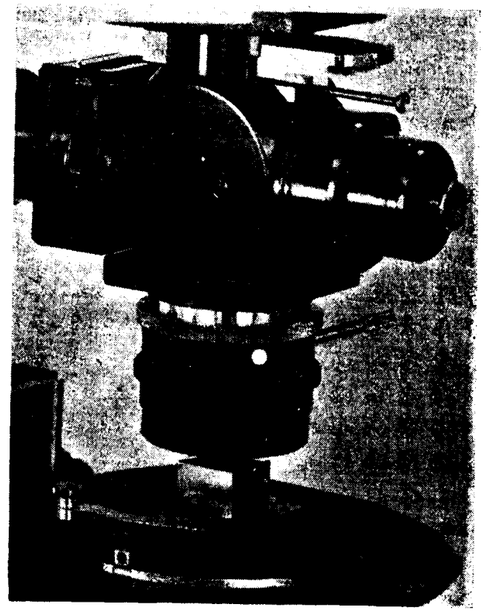

Fig. 9 "Nu" with Interference Attachment

hardness indentation relative to the line of slip of the specimen.

Three easily interchangeable indentation bodies will be supplied with the Micro-Hardness Tester "H", namely the VICKERS-pyramid, the BERKOVICH-pyramid and the KNOOP-pyramid. Whilst with the same load the four-sided VICKERS and the three-sided BERKOVICH-pyramid result in impression areas of the same size, the large diagonal of the impression of the KNOOP-pyramid is approximately three-times as long as the diagonal of the VICKERS-pyramid, whilst its height amounts to only 2/3 of the latter. The KNOOP-pyramid is therefore especially suitable for the determination of the micro-hardness of thin layers. The test loads graded from 1.25 . . 160g may be applied either individually or combined by putting them on top of each other for all three indentation bodies. When handling the Micro-Hardness Tester "H" in the right way, an impact accuracy of approx. 3 microns can be achieved. For measuring the hardness impressions the micrometer eyepiece is used in conjunction with the monocular straight tube.

WORKING WITH THE INTERFERENCE ATTACHMENT (Fig. 9)

As light source the "HBP 50" with a monochromatic filter must be used, the illumination being effected via the plane glass reflector. The Interference Attachment and the Plane-field Achromats 4× or 10× are screwed on to the objective slide and moved up to the incident-light condenser. Subsequently the objective is focused for the selected reference surface and thus prepared interference system for the specimen. The interference image is then adjusted by tilting and turning the reference surface.

The Interference Attachment can be used for testing the flatness of ground or polished surfaces for depth of roughness measurements.

Depending on the reflecting properties of the specimen the observation can be carried out with or without pancratic eyepieces.

A NEW KONIMETER (Konimeter 10)

PART I, CONSTRUCTION AND FEATURES

By Walter Thiele

DUST occurs everywhere in nature even without human influence. In modern industry and technology additional dust is produced either unintentionally as undesired results of processing and manufacturing methods or deliberately in the manufacture of powdery substances. The reduction of solid compounds to finely dispersed powders is assuming continuously increased importance in industry. Let us recall the food in powder form, the powders in the detergent industry, the painters and decorators colours as well as cement and carbon dust, the materials used in the building and fuel industry.

For people working in rooms where the air is contaminated by dust this may cause in addition to the unpleasantness of the dust, serious detrimental effects to health. The most important and best known example of such a source of danger is the silicosis [1] caused by quartz-containing dust. Also the manufacture of certain high quality products can be considerably impaired by dust. It should only be imagined what would happen if pharmaceutical products could not be processed in a dust-free atmosphere.

Therefore it is necessary to check the dust content in working and manufacturing places where dust occurs and to test the protective measures as to their efficiency. In the analysis of dust one differentiates, according to the prevalence of coarse or fine particles, between coarse and fine dust. Fine dust is dust, the particle diameter of which is less than 10 microns.

As the content of fine dust frequently permits conclusions to be drawn regarding the overall degree of dust without carrying out a comprehensive analysis, fine dust instruments are being applied successfully not only for measuring the fine dust but also for comprehensive analyses. Therefore numerous methods and instruments for fine dust measurement have been invented and developed.

The equipment discussed here can be subdivided into two groups. In the one group the dust particles contained in a certain volume of atmosphere are made to precipitate as a dust specimen. The specimen is evaluated subsequently separately from the dust deposit, usually in a laboratory. The evaluation is effected according to a method whereby the dust characteristics playing the most important part at any particular time are being determined, e.g. gravimetrically, i.e. weight per volume mg/millimicron or as particles per volume, i.e. T/cm³. The best known are the following :

THE THERMAL PRECIPITATOR

The dust precipitation is effected by utilising the thermal diffusion, i.e., a movement of atmosphere produced artificially by a heat potential and controlled by it. These instruments require an electric current for heating a tensioned wire from which the thermal diffusion originates. The dust containing atmosphere passes slowly along it. The heat generated deflects it so far to the side that the dust deposits on glass plates arranged at the sides. The slow and uniform aspiration of the air is effected by water flowing from containers [2].

THE IMPINGER

With these instruments the air is passed at high speed through a liquid, usually water, and the dust contained in the air washed out and collected. The dust to be tested must not dissolve in the liquid as the liquid must be separated subsequently from the dust in order to be able to carry out further analyses [3].

FILTER INSTRUMENTS

In these instruments the dust is separated by sucking the air through filters. The dust content of the filter is either determined by the increase in weight of the filter or by using filters of a material which can be completely dissolved so that only the dust to be investigated is left for further analysis.

KONIMETERS

With these the air is blown through a nozzle on to a prepared baffle plate on which the dust is precipitated [4], [5].

INSTRUMENTS, PRECIPITATING THE DUST BY MEANS OF ELECTROSTATIC CHARGES

The required electricity is produced by special high voltage aggregates or by frictional (static) electricity.

In addition to these specimen producing apparatus there are those of the second group where a measuring value is determined directly and put in relation to the dust concentration. *Tyndallometers* [6] based on turbidity and scattered light effects belong to this group.

Also the *filter resistance-measuring instruments* should be mentioned where the increase in the atmospheric resistance is used for measuring the concentration.

LOWE [4] lists the various instruments and their principles of application.

KONIMETRY

With fine dust problems it usually is not a question of the dust per unit of volume as with the coarse dust analysis but the number of particles per volume is the characterising measure of the dust concentration. This definition of the dust concentration is of importance primarily for tasks of social hygiene and industrial medicine because here it is not only essential to know exactly the type of dust but also the percentual proportion of those dust particles which according to their size can penetrate into the most minute pulmonary alveoli. If instead of the number of particles per volume the weight per volumetric unit would apply as measure, a single larger particle could simulate a high degree of dust coverage and dust containing many small particles which, due to their number, represent a dangerous amount of dust would not be taken note of because it literally does not " weigh anything ". Small particles of dust may always become dangerous to man when their particle diameter ranges from 10 microns to 0,1 micron whereby usually a somewhat narrrower range from 5 microns to 0,5 micron is regarded as definitely dangerous on the basis of many test results. In the series of listed apparatus for fine dust measurement, the Konimeters are outstanding by their simple operation, the speed with which dust specimens are obtained and the type of dust specimens themselves, which subsequently to the usual counting in konimetry are still suitable for other, more elaborate methods of analysis.

Below the basic principle mentioned in the list very generally is discussed in more detail.

The measured quantity of air (optionally 5 ; 2,5 or 1 cc) is aspirated by an air pump (Fig. 1). The aspirated air flows through a narrow channel, the aspirating nozzle. Immediately behind this nozzle not far from the aperture there is the object disc or baffle plate, a glass disc prepared with a suitable adhesive. On this the dust contained in the air is precipitated as a dust strain as the air current between the nozzle aperture and the specimen plate is deflected by 180° in a very small arc. The dust particles are thus thrown out of their tracks. Viewing the different stains under the microscope does already provide an idea about the dust concentration on the different test positions. By counting the precipitated particles, comparable measuring values are obtained (Fig. 2).

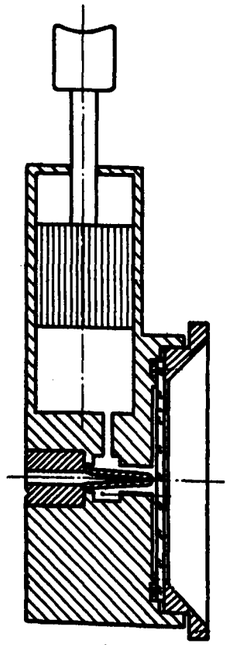

Fig. 1 Diagram of the basic principles of the Konimeter

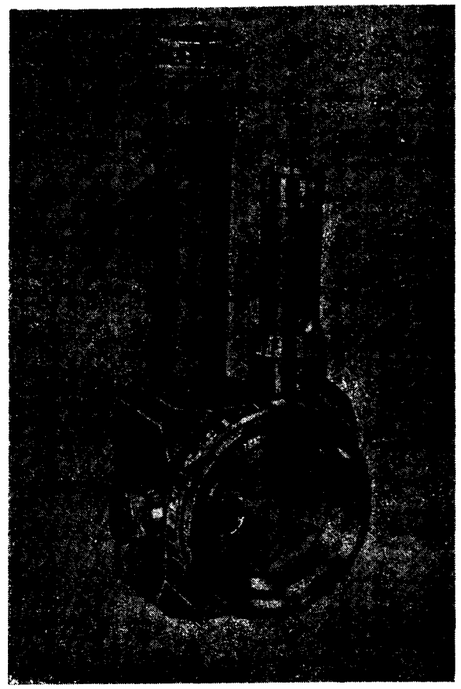

Fig. 2 Konimeter 10 (The new Konimeter)

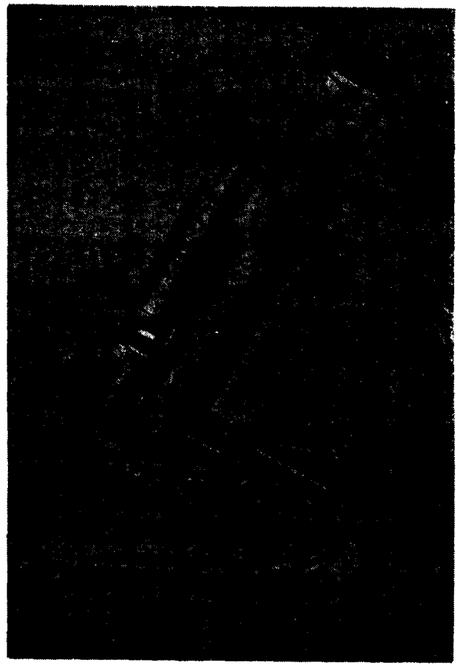

Fig. 3 Konimeter model I (The Konimeter manufactured so far)

All Konimeters work according to this principle (Fig. 3) and it has become possible to measure dust of a certain grain range up to a certain percentage. However, the percentage covered was different for each apparatus so that only measured results could be compared which were obtained with the same apparatus under the same conditions. This may have been sufficient as long as every dust expert had to analyse the dust specimens prepared by himself without reference to the measurements of others. As however with dust measurement, as with all measuring processes, demands are voiced for a general comparability and standardisation by means of national and international exchange of experience [7], [8], the Konimeters manufactured so far had to be tested and perfected with regard to these qualifications. For this purpose a number of basic questions had to be solved. These tasks were tackled by various people—an indication of the importance attaching to konimetry among the number of dust measuring methods [9].

ROEBER studied very carefully and thoroughly all the problems concerning konimetry so that by now all the theoretical principles can be regarded as clarified and certain. These investigations also proved that with a Konimeter a certain measuring range can be very accurately covered. The data of the instruments and their inter-relations with the measuring ranges fixed by them are now known [10].

For the new " *Konimeter 10* " developed by VEB Carl Zeiss JENA the measuring range required for social hygiene has been selected so that with the new instrument particles of less than 10 microns can be quantitatively determined. The new Konimeter corresponds also in other respects to the new experience in fine dust measurement thanks to the co-operation of Dr. ROEBER with our works. It has thus become possible to create an instrument with which the generally required comparability of the dust specimens, obtained with various Konimeters of this type, has been achieved. Because the entire development of this equipment is directed towards the requirements of social hygiene, also the requirements as stipulated by the Committee " Dust and Control of Dust " of the Board of Engineering and by the " Academy for

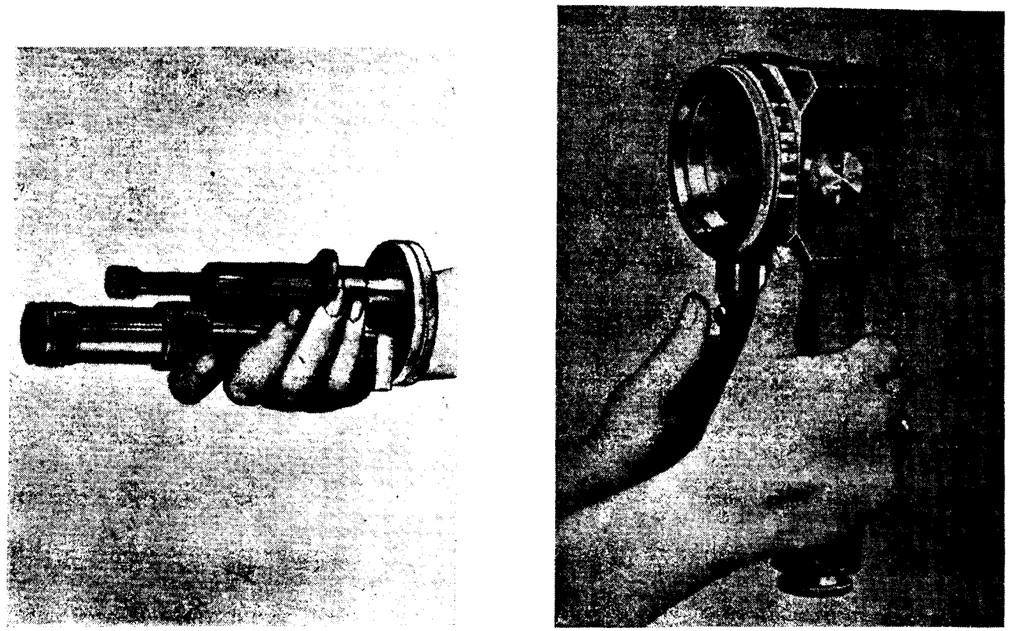

Fig. 4 How the former and new Konimeters are held when taking the dust sample

Works Hygiene, Social Hygiene and Medical Training, Central Office for the Control of Silicosis, Berlin-Lichtenberg " in actual practice have been taken into consideration when designing this new instrument.

Because of the quantitative separation it is possible to carry out comparisons with other instruments working according to other principles as long as such instruments ensure also quantitative deposits in the same grain range. Furthermore, the new Konimeter can be successfully used beyond the rated grain size as even in these instances a relatively good and well defined degree of separation can be recorded.

The special features of the new instrument are discussed below on hand of the individual parts of the equipment :

The new *shape of nozzle* effects a high aspirating speed of the air, but at the same time also the smallest possible aero-dynamic load on the dust particles. The coincidence of these two counter-acting features and their good adaptation to each other contributes essentially towards the favourable action of the Konimeter.

The *concentric drawing-off* of the air behind the nozzle which, although existing with the Konimeters produced so far, has been further improved with the new model so that the occurring dust stain has a circular shape with a uniform dust density existing within the area of the circle compared with which the proportion beyond the circle which is of much lower concentration, can be neglected without any great error occurring (Fig. 6).

The present *co-ordination of pump and nozzle* where the nozzle axis and pump cylinder are no longer parallel but at right angles to each other permits a more comfortable holding of the instrument when removing the dust (Fig. 4). The entrance aperture of the nozzle can be held for this purpose turned away from the observer and in a quite relaxed manner so that the smallest possible disturbance of the dust distribution occurs.

The tolerances are estimated accurately with regard to their effect on the measuring result and the strict adherence to these tolerances ensures a good reproducibility of the measurements made with different instruments.

Due to the *small size of the stain* it is now possible to analyse on a single object plate *40 dust stains* in a narrow circular zone when turning the plate from one field to another. In addition to the standard object plates made of glass, plates of heat-resistant material are available for purposes where the combustible proportion is to be separated from the pure proportion of pure rock particles.

The *clearance between piston and object plate* which cannot be entirely eliminated could be reduced to a minimum by the nozzle being at an angle to the pump. Thus it became possible to improve the degree of precipitation for a small aspirating volume so much that objections made against the use of a suction volume of 1 cc do not apply to the new Konimeter.

The *distance of the object plate* from the *nozzle aperture* is accurately maintained by the plate pressing against a metallic stop on being attached and screwed on. A rubber ring serving as a packing is compressed due to its own softness and specific profile without altering the distance. In this manner the dust stain is produced always on the same spot of the air current and under the same instrumental conditions.

Repeated pumping and *aspiration* above the same field of the object plate supplies an *additive increase of the dust separation* and thus an *extension of the concentration range* towards lower concentrations. For *extremely low concentrations* where even repeated pumping does not produce a well-defined and easily countable *dust stain* the *pump* can be unscrewed and instead a vacuum connection provided so that with a *vacuum line* continuous evacuation can be effected over any length of time until a dust stain of suitable density is obtained.

The *pressure spring of the pump* and altogether the pump as a whole has been subjected to thorough investigations so that by now more information than ever before is available about the dependence of the degree of separation on the force of the spring and its effect on the evacuating process. Compare with ROEBER's article " Analysis of fine dust measurement, especially with Hand-Konimeters " [11].

These investigations have shown that the starting-up process, whilst the speed of the aspirated air reaches from zero to a maximum value, requires only a fraction of the time of the entire lift of the piston. This is made possible because the accelerating masses are small by virtue of the plastic of which the piston is made. The maximum speed achieved is accordingly maintained during the main part of the entire lifting time in order to drop back to zero only towards the end of the process. The period of the even flow and the magnitude of the attained maximum speed determine decisively the quantity of the aspirated quantity of air and the efficiency of the Konimeter. A temporary slight recoiling at the end of the piston lift is without importance compared with this ; it is rather a proof that no additional air penetrates into the Konimeter due to leaks in the chamber which is under low pressure during the aspirating process. The piston is shaped in such a manner that it closely adheres to the cylinder wall even at *extreme temperatures* without its sliding capacity being impaired. Compare this with the article by MOBIUS [12] to be published in No. 2/1962 of the JENA REVIEW.

The pump does not require any special maintenance, nor is it necessary to dismantle it for greasing.

To check the efficiency of Konimeters which have been in use for a prolonged time and to keep all instruments at the same level of efficiency a special inspection service is provided. A number of testing stations are enabled to obtain special testing instruments with which the most important properties of the Konimeter and thus the uniform functioning of each instrument can be checked at any time.

The dust stains obtained can be viewed immediately by means of an attached microscope when the dust is removed. For this purpose the dust stain underneath the nozzle must be turned under the microscope aperture. By providing the same numbering for the object plate and setting ring it is possible to ascertain with special setting marks which field is at any time underneath the nozzle or underneath the microscope. The *new arrangement of the nozzle* in respect of pump and *microscope* makes it possible to place the instrument on a base or holding it comfortably in front of oneself (Fig. 5) during observation through the microscope.

The *new optical equipment* of the microscope with a Plane-field Achromat of great aperture (Plane-field Achromat 63 × 0,80 00/O) and the special eyepiece with a widened field of view supplies the well-proven 200 times magnification. By an *improved flattening of the field of view* a uniform definition over the entire range is obtained. The greater aperture increases the image contrast so that even from the optical point of view the requirements of social hygiene for recognising

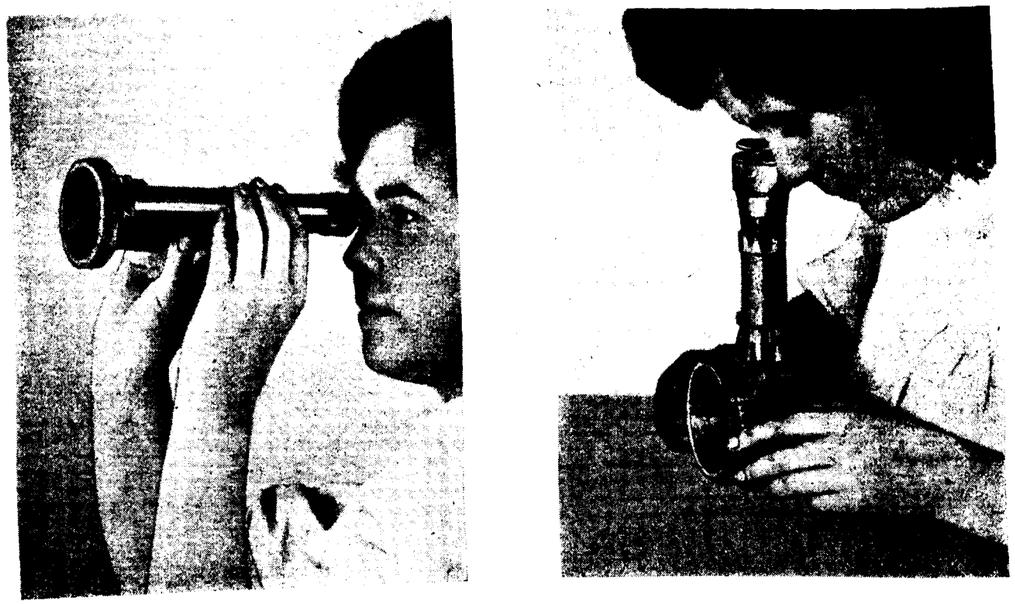

Fig. 5 How the old and new Konimeters are held during microscopic observation

Fig. 6 Dust stain produced with the new Konimeter without Pre-Konimeter

small and minute particles are adequately met. Pump body and optical system are correctly adapted to each other.

A *low-placed focusing knob* facilitates the operation of the microscope. By favourably arranged setscrews the image of the dust can be moved in two directions perpendicular to each other and thus placed accurately into the centre of the field of view. This is subdivided as usual by an eyepiece micrometer into squares and into a sector passing through the centre. Thereby, and by means of the *centering possibility* it is also possible, even when counting a stain only partially, to extrapolate the total of the particles with a high degree of accuracy. The Konimeter does not require *any electrical energy* for its use. It can therefore lend itself for use even where, in addition to dust generation, there is also the danger of self-ignition and explosion. This dispenses entirely with the limitations due to connection to energy sources or required spare parts or wearing parts for replacement, such as electrical batteries; additional protective measures against the danger of explosion are not required either. *The Konimeter can be used anywhere and at any time.*

A *Pre-Konimeter* (Fig. 7) can be attached for dust

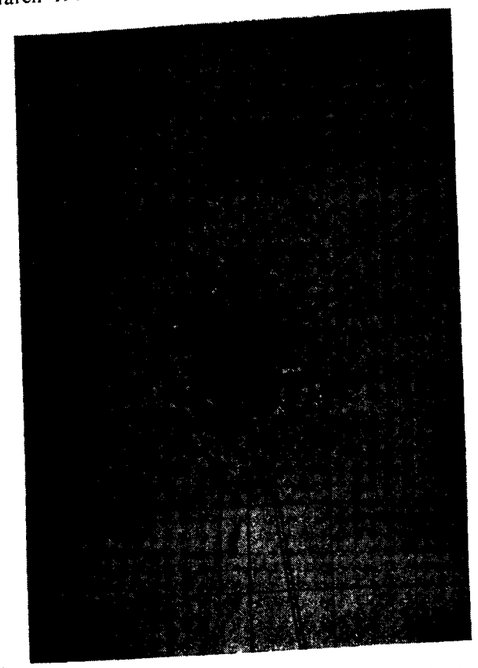

Fig. 7 Dust stain produced with the new Konimeter with Pre-Konimeter

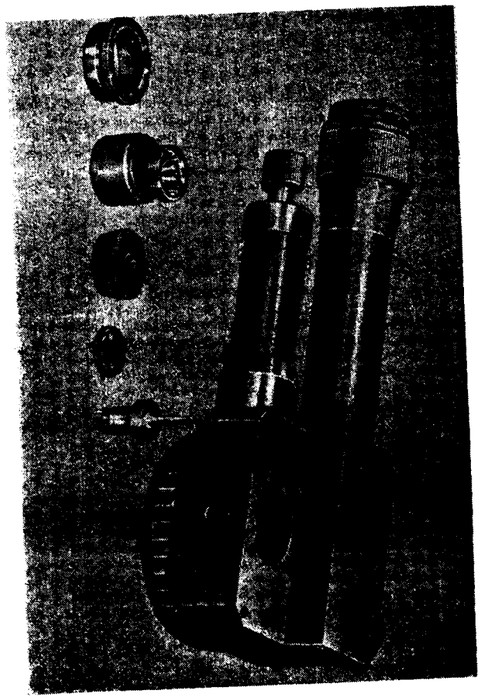

Fig. 8 Konimeter 10 with its various components and ancillary parts

containing a lot of coarse particles. This instrument, similar as the Konimeter, has a limited measuring and precipitating range which has been fixed in such a manner that coarse particles are separated.

In this manner the co-ordinated action of the Pre-Konimeter and the Konimeter permits a separation of the dust into coarse and fine particles and the konimetric fine dust preparation is thus not rendered unsuitable for measurement by the coarse particles. The methods for dust viewing applied so far use screens and sedimentation chambers. The preliminary precipitation is considerably simplified by the Pre-Konimeter (Fig. 8).

A *projecting device* being prepared into which the Konimeter can be inserted. For this purpose the attached microscope is used simultaneously as a projecting microscope. Due to the optical system used the Konimeter is excellently suited to this additional application. The firmly built-in illuminating device will be such that under the conditions known in microscopy, described as the KOHLER illuminating principle, it will be possible to carry out work in transmitted light with 500 × magnification. Thus not only a standardisation of the dust preparation but also of the methods of operation and evaluation is achieved. As it is no longer required to remove the object plate from the Konimeter for evaluation, the danger of additional soiling is dispensed with, which existed so far with a separate evaluating apparatus.

In conclusion attention should be drawn to ROEBER's publication "Analysis of fine dust measurement, especially with Hand-Konimeters" [11] as a general survey of the most recent experience in konimetry.

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CARBON STEEL BARS, BILLETS, BLOOMS AND SLABS FOR FORGINGS

The Indian Standards Institution has published IS: 1875–1961 Specification for Carbon Steel Bars, Billets, Blooms & Slabs for Forgings, which prescribes the requirements for four grades of carbon steel bars, billets, blooms and slabs for forgings designated as Class 1, Class 2, Class 3 and Class 4.

Metric system has been adopted in India and all quantities and dimensions in this standard have been given in this system. However, for the sake of smooth changeover by December 1966, non-metric values have also been given wherever necessary.

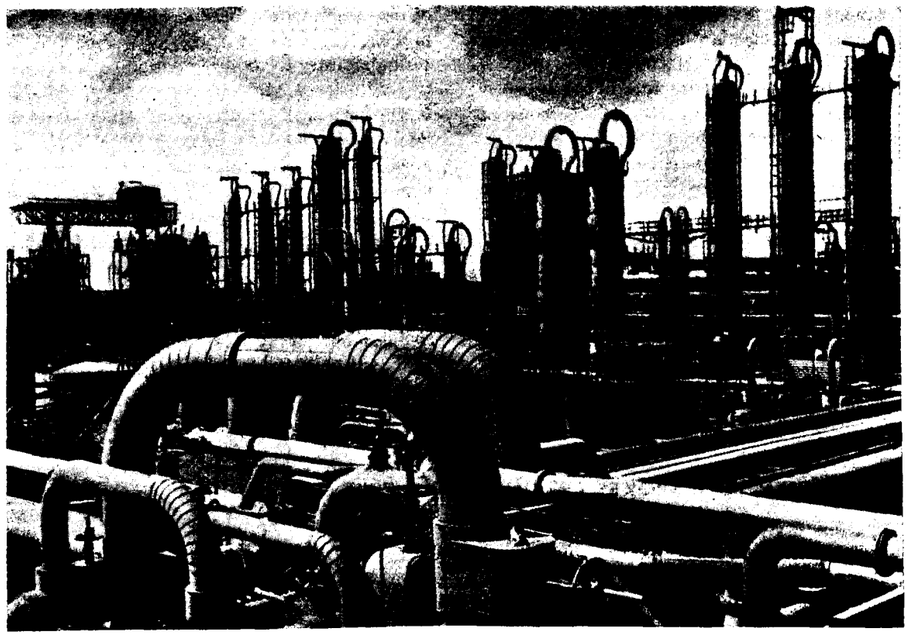
New Chemical Industry Centre in Ruhr District

Contribution of Hüls Chemical Works & Co. (Chemische Werke Hüls Aktiengesellschaft) to the advancement of the **German Chemical Industry & Research programmes.**

By A Special Overseas Correspondent

"RESEARCH today safeguards the production of tomorrow" said Prof. Paul Baumann, Chairman of the Board of Directors of Hüls Chemical Works & Co. (CWH). This principle has been responsible for the success and growth of a firm to the fourth largest chemical concern in the Federal Republic of Germany. This Chemical centre on the northern border of the North-Rhine Westphalia Industrial belt, employing 60,000 workers produces about 700 different articles which reach 83 markets through a world-wide sales organisation. Originally planned to produce only synthetic rubber BUNA, this modern and well organized factory grew in an area, which was till 1938 completely desolate, lying between the towns Munster and Recklinghausen, very close to Rhur mining district.

The first tone of BUNA was produced in 1940. After the war, a completely new orientation of the production scheme was necessary. The chemists and technologists stood before the not so easy task of setting up a programme which would safeguard the continued usefulness of the plant and its various departments. However, in the end they were successful. The regular allotment of funds, amounting to 5% of the turnover for research (which was not less than



Modern Chemical Industry: Kilometre long pipes and distillation columns rising in the sky. The synthetic products which are playing an ever-increasing role in our lives are manufactured here.

35 million DM in 1960) yield good results. This success was possible because of a purposeful production and sales policy, working hand in hand with a balanced investment programme, which guaranteed not only a fixed market, but found new markets too.

It is therefore not surprising that besides many reputed German firms, important American Chemical concerns are also interested in a collaboration with CWH. Recently for example a partnership Hourdy Hüls Catalyst Works Ltd., was founded, which chiefly sells catalysts to the chemical and petroleum industries and in the near future will also produce them. In collaboration with the Tennessee Eastman Company (Kingsport/U.S.A.) Hüls Fibre Works Ltd., was established, which will shortly bring to the European market a new polyester fibre under the name VESTAN. Through the different affiliated companies, Hüls can now make an even better use of its sources of petro-chemical raw materials. The main productions of Hüls since the end of the war are raw materials for plastic industries. In addition to this, raw materials for synthetic washing powder, varnishes, chlorinated hydrocarbons, intermediate products for textile industry. Glycol and its derivatives, as well as many other organic and inorganic products are produced. Among the existing annual production capacities, let us only mention 80,000 metric tons of Vestolit (Polyvinylchloride), 30,000 metric tons of Vestron (Polystyrol), 6000 metric tons of Vestolen A (low pressure polyethylene) and 3600 metric tons of Vestolen (Polypropylen). About 70% of the raw material required for production come from petroleum and its byproducts. The remaining 30% including over 100,000 metric tons of Benzol, are obtained from coal. Upto 75% of the power necessary for manufacturing comes from 2 private power stations with installed capacity of 350,000 KW. Not less than 2% of the total power consumed in the Federal Republic of Germany goes to Hüls.

The sales products of lac materials range over large varieties of solvents, from plasticizer, synthetic resins to dyes and adhesives. Vestinol (Plasticizer. softener) as well as Vestopal (Polyester resin) groups of materials, like the wide choice of Litex products (adhesives based on synthetic rubber latex) could quickly capture a considerable market. For this success credit goes to the applied technology department of CWH, which has an important say in the introduction of new products. The objective and often individual guidance from this department produces in a short time an atmosphere of trust between Hüls and its customers all over the world. Only thus can we explain the fact that today 80% of the Hüls sales are due to products which were introduced only after 1950 (the undertaking was originally planned for the production of BUNA only).

The production of BUNA, which started in 1940 on 3 sq. kilometre area, has been completely handed over to Hüls Buna Works Ltd., lying in the immediate neighbourhood. Besides CWH (50%) other companies like Bayer & Co., Badische Aniline & Soda Fabrik as well as Farbewerke Hoechst & Co., are partners in this firm. The new synthetic rubber factory can produce annually 120,000 metric tons Huls Buna. Its production plant, to a large extent automatically controlled, is one of the most modern ones in Europe and its different products enjoy, for instance, also in the tyre manufacturing industry the best reputation.

This technical achievement of Hüls Chemical Works AG would not have been possible, if at the same time equal attention had not been paid to the social problems. Uptil now more than 4000 houses for employees have been either built or financed. An old age pension for all the employees guarantees a secure retired life. Playgrounds have been generously built and modern arrangements for proper medical care have been made. All this completes the picture of a sound industrial potential which might provide impetus to the further development of the new district on the border of Ruhr area.

BICYCLE SPOKES (PLAIN) AND NIPPLES FOR SPOKES

The Indian Standards Institution has published a revision of IS:630 Specification for Bicycle Spokes (Plain) and Nipples for Spokes which prescribes the requirements of bicycle spokes (plain) and nipples and washers intended for use with them.

This specification which was first issued in 1955 as tentative has now been revised and issued as a firm standard.

Metric system has been adopted in India and all dimensions in this standard have been given in this system.

ELECTRICAL INDUSTRIES ANNUAL SUPPLEMENT

The Beginnings of Electrical Engineering

By Mr. Harold Sharlin,
Assistant Professor, Department of Economics and History,
Polytechnic Institute of Brooklyn, Brooklyn. N. Y.

[Electrical Engineering as a Science dates from the second half of the 19th century. The development of the Telegraph industry, with its technical problems that were overcome only through fundamental research in electrical phenomena, furnished the greatest impetus to the growth of the profession and the establishment of its professional societies.]—Editor

WHAT is electrical engineering? When did it begin? The answers to these two questions are closely related. Modern electrical engineering is a wide and diffuse field. The men who first defined the field had some misgivings about being too narrowly specialized but as knowledge of the field has grown so has the profession. If it were possible to pick the point in history when technique and craftsmanship became science and engineering, we could gain some insights into a complicated field. Although we cannot pick a point, we can pick an area and that area is the electric telegraph.

The Society of Telegraph Engineers was established in 1872 for " the general advancement of Electrical and Telegraphic Science and more particularly for facilitating the exchange of information and ideas among its Members ". This Society was the predecessor of the Institution of Electrical Engineers (IEE) and the American Institute of Electrical Engineers (AIEE) But the telegraph was invented in 1837, Why was there no need felt for such an organization of engineers until 1872 ?

Within a few years of Oersted's discovery of the magnetic effect produced by an electric current and Ampere's description of electromagnetic force, men were building electromagnets which could lift astonishingly heavy loads. Sturgeon improved the attractive force of these artificial magnets by winding wire on an iron core. Henry, in the United States, found that the attractive force could be considerably increased by multiplying the number of loops of wire on his magnets. No wonder there were numerous men who rushed forward in the period from 1825 to 1837 with electric telegraphic devices. All of the ingredients were available, a steady source of current was available in the battery, conductors had been made that could conduct the current over great distances, and the magnetic properties of an electric current could be used to detect the reception of signal impulses.

EARLY INVENTORS' THEORY MEAGRE

No engineering was necessary to bridge the gap between scientific theory and a successful invention. The theory was simple enough for an amateur to understand and the device needed only to be a simple mechanical application of what was already known. It is significant that the two men most responsible for the successful introduction of the telegraph knew hardly anything about electrical science. William Cook, in England had assisted his father in anatomical studies before he began work on the telegraph. Morse, the American was a painter.

Each inventor worked on slightly different principles. Each eventually raquired the services of an experimental physicist. Cook's device was a direct application of Oersted's discovery. Oversted had found that a magnetic needle tended to orient itself perpendicularly to the wire. If the current in the wire was reversed the needle would point in the opposite direction. Cooke devised a diamond-shaped board with five magnetic needles spaced across the widest part. Each needle was under the influence of a separate wire. The needles would pivot to the right or the left depending on the direction of the current sent from the transmitting end. The needles served as arrows. Currents would cause two of the needles to move and the intersection of lines through the needles would indicate a letter or number.

Cooke found it necessary to seek the help of Charles Wheatstone, the physicist. The two men were granted a patent on their telegraph instrument in 1837. Their device had the advantage of simplicity of

operation. There was no need to train operators since all they had to do was to be able to read the alphabet. The Cooke and Wheatstone telegraph had the economic disadvantage of requiring six wires between transmitter and receiver. This requirement raised the cost of their system over that of Morse's.

Samuel Morse learned enough about electricity of an ocean voyage from Europe to invent his telegraph. His device made use of the magnetic force of an electric current that had been discovered by Ampere and applied by Sturgeon. The magnetic force produced by a current from the transmitter forced a stylus down on to a piece of paper. The stylus caused indentations which were in the form of dots and dashes, a code invented by Morse. Morse's instrument required a trained operator but only two wires.

The history of the wiring of our continent is primarily an economic story. Science and engineering, unfortunately, played practically no part in the spectacular feat. Morse, his associates, and his competition were faced with the problem of making this new method of communication pay. There was considerable difficulty in raising enough money to pay for the stringing of the wires. The public, both individual and business, had to be coaxed into using the system. Lack of dependability was the chief complaint against the telegraph.

The New York Boston line which was first strung in 1846 was an example of operating conditions of the time. The mechanical difficulties were only one aspect. After the first storm 170 breaks were reported over a distance of 30 miles. To avoid breaks, the copper wires had been strung with plenty of slack. The result was constant crossing of lines. This difficulty was something a person with only rudimentary knowledge of electricity could have avoided.

Pity the foreman on the New York-Boston line. " Yesterday I examined 59 posts and found the wires resting on the screws in 74 instances " he wrote in a report on one of the divisions. " They had not the appearance of having been drawn down by the weight of the wire, but were probably left so at the time they were put up. If there were no further difficulty, what I have discovered would be sufficient to account for failure to get the circuit through ".

RAPID SPREAD OF TELEGRAPHY

But once Americans saw the usefulness of communication by telegraph to connect the rapidly expanding country, telegraph lines were strung at an astounding pace. By 1848, just 4 years after the first successful line from Baltimore to Washington (40 miles), 6,000 miles of wire were in operation. In 1852, 16,729 miles of wire were in operation out of a world-wide total of 23,275 miles. One can only conclude that this feat was accomplished by some magnificient muddling through.

The British by the same year had only 4,000 miles of telegraph line in use. The English were making slow progress in the field of telegraph technology but the Americans, in spite of the impressive mileage record, had learned practically nothing. In 1867, the United States Telegraph industry appealed to the British to send an engineer who was qualified to make a survey of the American lines with the object of recommending standards of voltage, current, and resistance for circuits and instruments. The man who came was C. F. Varley and he brought standards of operation up to those of England and the rest of Europe.

The Components of the telegraph system were simple and few. There were the connecting wires, the motive power and the instruments. One English engineer complained in 1852 that " the motive power, the widest field for substantial improvement, with very slight modification, has been left in its original expensive, unwieldy and ineffective form ". Why was there neglect in this area ? Because the improvement of the battery would have required more theoretical knowledge than any of the telegraph inventors had. The scientists, who could have done something, were not interested and there were no engineers trained for that kind of work.

English engineers were looking for a method of insulation which would be dependable and cheap. Cooke and Wheatstone had originally used cotton and shellac covering for their wires but the cost was prohibitive : 300 pounds sterling per mile. Suspending the wire on poles proved to be best method. This method reduced the cost to one sixth of the original. Edwin Clark patented an insulating cap for attaching the wires to poles which completely overcame all difficulties " except those arising from fog ". Gutta percha was adopted by many in the hope that it would be a cheaper and more efficient insulator. It was too expensive to be used generally but it found wide use in subterranean and submarine cables.

INVENTIONS SPEED TELEGRAPH TRANSMISSION

The most attention was paid to the telegraph instrument where, as one telegraph engineer said : " The inventive faculties appeared to be inexhaustible .... " But in this area there was no need for physicist or engineers for " in fact, any ingenuous clockmaker could produce modifications of them, and the ink on the receipt for the purchase of one would scarcely be dry, before another, perhaps better and cleverer would be offered from the same fertile source ".

The object of all this ingenuity was to increase the speed of telegraph transmission beyond the limit imposed by hand signalling of 150 letters per minute. One system invented by Wheatstone was called an automatic system because the transmitter was keyed by a strip of punched tape. Wheatstone also made use of double currents that is positive and negative pulses and introduced series capacitance to reduce the inductive time lag on the instrument's magnetic coils.

David E. Hughes, a Kentucky teacher, invented a printing telegraph in 1855. Insted of the clockwork mechanism previously used, Hughes constructed instruments which had wheels that had to be kept in step. The transmitter resembled a piano keyboard with 28 keys. The message was printed on tape at the receiving end.

A. M. Baudot, an operator for the French Telegraph Administration made use of his idle time between messages to invent an ingenuous and widely used telegraphy system. The system made use of a code invented by Gauss and Weber which consisted of five units of either positive or negative current pulses. The operator depressed five keys like a piano keyboard. The operator had to play in time with a cadence tapper. At the receiving end five currents were delivered to five electromagnets. Each electromagnet attracted an armature which pushed a rod which shifted a peculiarly shaped lever. Each letter of the alphabet corresponded to some combination of levers. The message was printed on tape at the rate of 150 letters per minute. The Baudot system was widely used in Europe.

In the United States a system invented by Donald Murray was used by Western Union. The Murray machine was on the same general principle as the Baudot machine except that instead of using the cadence-timed transmitter it used a previously punched tape. Murray's receiver printed the message in page form.

Three telegraph systems were widely used throughout the world, namely the Wheatstone automatic, the Hughes printer and the Baudot printer. Another method of making fuller use of the lines and increasing the number of messages which could be handled was by sending more than one message at a time. The first suggestion of duplexing was made by J. W. Gintl of Vienna in 1853. A really practical solution to the problem was found by a Bostonian in 1868. The ultimate in the crowding of the wires was achieved by Edison with his invention of the quadreplex telegraph which sent two messages in each direction at the same time.

PROBLEMS OF SUBMARINE TELEGRAPHY

The extension of a telegraphic line across the Atlantic Ocean was at first assumed to be a simple extrapolation of the method of installing overland telegraph. As it was, most of the problems of the Atlantic Cable were mechanical and the electrical difficulties were solved with only a slight extension of theory.

Wheatstone had suggested before a committee of the House of Commons in 1840 that it was practicable to pass a submarine cable from Dover, England to Calais, France. The first such cable was completed in 1851 but only after the discovery of gutta percha made it possible to protect cable from the sea water. The first Dover cable seemed to be a lucky chance because three successive attempts to repeat the laying failed. This cable was only 20 miles long. Gradually the length was increased ; one to Holland was 115 miles, another across the Mediterranean was 110 miles. In 1855, a 350 mile cable was laid. By this time men began to view the Atlantic as the next step.

Experience with cables much shorter than the projected 1,900 mile Atlantic cable convinced some that it would take too long to transmit messages that distance. In other words the Atlantic cable, according to some was possible but would be unprofitable. A transmission rate of about one word per minute was predicted. Faraday suggested that the difference in rate of transmission between a suspended wire and a submerged wire was due to the Leyden jar effect of the

action between the conductor and the surrounding water. But he estimated the time of transmission as 2 seconds. William Thomson even reduced this estimate to four signals per second. Thomson's mathematics and experiments supported Faraday's intuitive views. In a paper before the Royal Society in 1856, Thomson had demonstrated the theoretical basis for the Atlantic cable :

> From these investigations it appeared that without any direct trial on long subterranean or submarine wires, but by reasoning on the known facts and measurements regarding electric conduction through copper and electric induction across solid insulators there were strong grounds for confidence in expecting that a message of twenty words would not require more than seven minutes for its delivery.... There was reason even to think that, that rate might ultimately be exceeded...."

Preliminary investigations by the directors of the first Atlantic cable company arrived at the erroneous conclusion that " large coated wires used beneath the water, or the earth are worse conductors, so far as velocity of transmission is concerned, than small ones..."

The heretofore unnoticed property of electric wires which is now called inductive capacitance, Faraday's leyden jar effect, was the most difficult theoretical problem of the time. After the 1857 failure of the cable an engineer wrote :

> " There seems to be a great deal of uncertainty, in the minds of those engaged in applying electricity practically regarding the laws of conduction and induction ; and consequently the nature of the conductor which should be employed for long submarine circuits ".

The failure in the cable in 1858 was an electrical one. The break in communications was particularly disheartening because of all the gigantic physical difficulties involved in such a project. A generally accepted theory was that the insulation had failed, partly because of abuse it sustained in manufacture, storage and laying of the cable. Thomson believed that the failure was caused by impressing the extremely high voltage for telegraph, of approximately 2,000 volts. The telegrapher who impressed such a high voltage had the popular misconception that the capacitance of the cable reduced the current in the cable. It does not. What the capacitance did was to cause the current of the telegraphic impulse to build up gradually instead of instantaneously as it would if there were only resistance present. To some the strange behaviour of electric current in submarine cables seemed to reopen the question of the character of the electric fluid. The contrast between current it suspended telegraph wires and submerged ones, made many believe that they were dealing with entirely different kinds of electricity.

The more advanced theoreticians could not accept this view and could not believe as one wrote " that Nature, whose laws, science, as she progresses, invariably discovers to be simpler, and still more simple, should have one way of transmitting a current along one wire, another way of sending it along another...."

The speed of electricity through a cable was infinite. That is, there should be no delay between the transmission and reception of a current. Cromwell Varley wrote :

> "The mistake, as to the non-instantaneous conduction of electricity has arisen from noticing only the arrival of the electric wave towards its maximum power, and not to its commencement. The apparatus used being only capable of recording when the wave had reached a considerable intensity, the first and weaker portions of the wave were not observed.... Electricity having neither momentum nor inertia, being incompressible into a conductor and being capable of travelling through any length of line must begin to flow out at one end, simultaneously with the application of the battery, at the other. "

William Thomsons galvanometer solved the last of the electrical problems connected with the Atlantic cable and all long-distance wire transmission. Actually Thomson's device sidestepped the problem of capacitance, but it was the simplest solution to a problem which presented difficult theoretical concepts for that time. His galvanometer was so much more sensitive than any other receiver to date that it reacted to the " first and weaker portions of the wave ".

The Atlantic cable was successfully laid on the fifth attempt in 1866 but electrical engineering, the practical application of the science of electricity, had barely begun. The theoretical concepts on which the telegraph was based were developed by scientists like Ampere, Henry, Faraday and William Thomson. The installation of a vast overland network of telegraph lines was accomplished by " Clockmakers " and technicians unskilled in electricity. The result was clumsy, inefficient and almost disastrous work.

Electrical theory on the other hand gained much from the experience of the telegraph. The most universal and significant concept to come out of telegraph work was that of capacitance. Yet there were scarcely any who realised its far-reaching importance. " Electricians " who were more and more called electrical engineers, still had to gain much of their knowledge the hard way, through failure. Ferranti, when he built his power cable from Deptford to London, was troubled at first by the capacitive effect of this concentric cables. He corrected the trouble by redesigning his cables. It took some time for engineers to recognise the similarity between capacitance in the direct currents of telegraph transmission and the capacitance which occurs in low-frequency telephone transmission. The theoretical and practical solution to the problems of capacitance in transmission lines was not solved until 1900 when Pupin demonstrated, mathematically and experimentally the benefits of loading such lines with inductance.

GROWTH SPURS FORMATION OF SOCIETIES

One stage in the development of any profession is the formation of a society which provides the essential function of aiding the exchange of information. As we have seen, the telegraph at its outset was treated as a mechanical contrivance, and logically, discussions on the telegraph were of interest to civil engineers. But there was so much else of importance that the telegraph received scant attention from this group. Papers and discussion on the telegraph were given before the Institution of Civil Engineers in England. All of the papers on this subject given between 1852 and 1865 fill only two thin volumes. These papers dealt largely with the non-electrical problems. For example, in 1857—1859 session of the society had three papers dealing with the submarine telegraph. Two of the papers dealt with the problems of paying out the cable. The discussion on the papers each occupied four consecutive meetings. The papers and discussion occupied 148 pages of the PROCEEDINGS. The third paper dealt completely with the electrical aspects of the cables. It was read in abstract and there was no discussion because as the secretary of the Society explained in a footnote " of the number of evenings already devoted to the same subject ".

As Priestly had said, 70 years before it was high time " to subdivide the business, that every man may have an opportunity of seeing everything that relates to his favourite prusuit...". The Society of Telegraph Engineers was established in 1872 for " the general advancement of electrical and Telegraphic Science and more particularly for facilitating the exchange of information and ideas among its Members. " The men who first formed the Society had misgivings because as the first president said :

> .... shall we not degenerate thereby into " specialists " or what may be called " fractional quantities of scientific men " and this in face of the patent fact that the further we advance in scientific knowledge whether pure or applied) the more clearly we perceive to intimate connection between its different branches and the impossibility of cultivating one without constantly reverting to the others.... But our time is limited and although the great principles of nature may be understood generally by one person, their applications are infinite and all we may hope to do is attain a general scientific basis and with it to devote our energies vigorously to the details of one or two branches of applied science.

There was really no need to fear overspecialization. The founders of the IEE and the AIEE acted at the moment just before electrical engineering spread across the whole field of modern technology. The years immediately following marked the beginning of the profession of electrical engineering.

(By courtesy : Electrical Engineering)

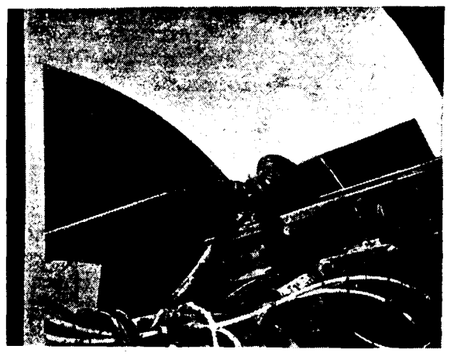
The Protective Coating of Hydro-electric Tunnels and Penstocks

(Public Relations Dept. — Coating Contractors Ltd.)

IN 1960 E. & F. Richardson Limited were awarded a contract by the Central Electricity Generating Board for the protective coating of all the steel tunnel linings and penstocks for the Ffestiniog Pumped Storage Scheme and the Rheidol Hydro-Electric Scheme. The methods now being used by their associate company, Coating Contractors Limited, are in many respects new and probably represent one of the first applications of automatic surface preparation, followed by the application of high build catalysed coatings by hot spray technique.

The Ffestiniog scheme is situated in Merioneth, the upper reservoir being formed by the enlargement of the Llyn Stwlan by the erection of a 100′ high massive buttress dam. Two intakes feed 14′ 6″ diameter vertical shafts 680′ deep, each shaft bifurcating into two 9′ 5″ diameter tunnels, each of the four tunnels being 3,800′ long. These tunnels emerge from the mountain side 200′ above the 300 M. W. Power Station where they feed four 7′ 6″ diameter penstocks of "Coltuf" steel encased in prestressed concrete. A gravity dam 1,800′ wide and 40′ high across the natural basin of the Afon-y-Stradu stream forms the lower reservoir.

The Rheidol scheme on the other hand is a more orthodox hydro-electric project in two stages, the upper stage being fed from the Nanty-Moch reservoir, situated behind a 170′ high massive buttress dam. The water is conveyed through a 9′ 6″ diameter tunnel to the Dinas Power Station of 12 M. W. output. The tailrace from this Power Station discharges into an intermediate reservoir from which the water is conveyed through a further 9′ 6″ diameter tunnel to the Power Station at Cwm Rheidol of 36 M. W. output. The tailrace of this Station discharges into a regulating reservoir, in the dam of which there is housed a further 1 M. W. generating set.



One of the 3 blast guns operated by the blasting manipulator. Each gun cleans a 125° band 3 feet wide.

The Ffestiniog Pumped Storage Scheme represents the largest scheme of its kind in the world and the first pumped storage scheme to be installed in the United Kingdom. The Consultants and the Central Electricity Generating Board considered most fully the means to be employed for protecting the steel tunnel linings and penstocks from corrosion and abrasion and a very comprehensive series of tests were carried out, the results being utilised for both projects. These tests started in 1959.

Looking down No. 1 Penstock towards the first of four vacuum blasting machines.

At a very early juncture the Central Electricity Generating Board and their Consultants decided that whatever coating system was to be employed, surface preparation by blast cleaning was virtually essential and therefore, all subsequent tests were carried out on blast cleaned panels.

The requirements laid down by the consultants in the first instance were for a protective coating having the following general properties :—

1. It should protect the substrate from corrosion for a long period, a minimum of ten years being indicated. For this purpose it should have the following intrinsic properties :—

   A. Good adhesion

   B. Low water vapour permeability

   C. Good resistance to rust creep

   D. Resistance to water of the type that would be present in the tunnels.

All of these properties were required at the temperature, pressures and water velocities prevailing in the steel tunnels and penstocks.

2. In addition the Consultants required :—

   A. A smooth finish in order to provide good flow characteristics. (This was particularly important at Ffestiniog)

   B. B. An electrically insulating material

   C. A material that did not embrittle at low temperatures, or flow at high ones.

A number of specialist manufacturers were invited to submit suitable materials, together with an assessment of the cost of their application, and these were tested in two concurrent series of trials, carried out on site by the Consultants and at their Laboratories at Leatherhead by the Central Electricity Generating Board.

The selected materials (some manufacturers submitted more than one system) where then applied by the manufacturer's representative, witnessed by either the C.E.G.B. or their Consultants. The panels were of heavy gauge mild steel, measuring approximately 10″×15″, and were shot blasted to a white finish with 24 gauge or similar crushed iron grit. Each material, or system, was applied to a number of panels and in each series one panel was dampened with water before being given to the applicator. Panels coated at Ffestiniog were immersed in a purpose made rack, which was mounted within a diverted water course on site and a similar arrangement existed for the panels at Cwm Rheidol. The panels were subjected in these racks to a flow of the identical water that would exist in the tunnels, though the velocity and pressures were different. Panels coated at Leatherhead were subjected to a series of laboratory tests designed to establish bond strength, abrasion resistance, water permeability and other relevant qualities.

E. & F. Richardson Limited submitted for these tests two systems, as follows :—

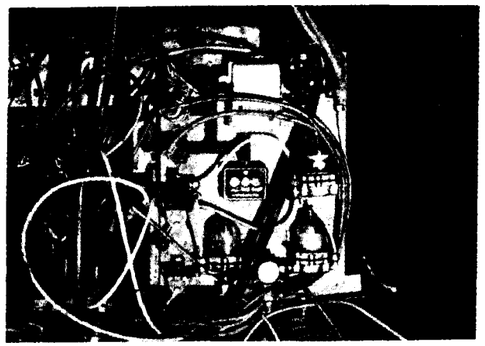
A. Neoprene Adcora P7 Primer, followed by a multi-coat brush application of Neoprene Adcora P6 to give a nominal dry film build of 0.030″.

B. Adcora A3 coal tar/epoxy coating applied in a multicoat application (by spray at Ffestiniog and by brush at Leatherhead) to give a nominal dry film build of 0.020″.

Whilst the full test report cannot be published, it is understood that similar results were obtained from panels tested at all three locations and that one of the most outstanding coatings was the Neoprene system submitted by E. & F. Richardson Limited, particularly so far as corrosion, abrasion and bond strength were concerned.

In the site tests, perhaps the most searching factor was the damage resulting from the high percentage of suspended solids in the streams in which the panels were immersed. At Leatherhead emphasis was placed on bond strength, and the adhesion obtained on the panels submitted by various manufacturers showed a very wide range from 200 lbs. per sq. in. to better than 1,440 lbs. per sq. in., in the case of Neoprene Adcora P6.

Following these tests the Board carried out some further work on a larger scale to assess the practicability

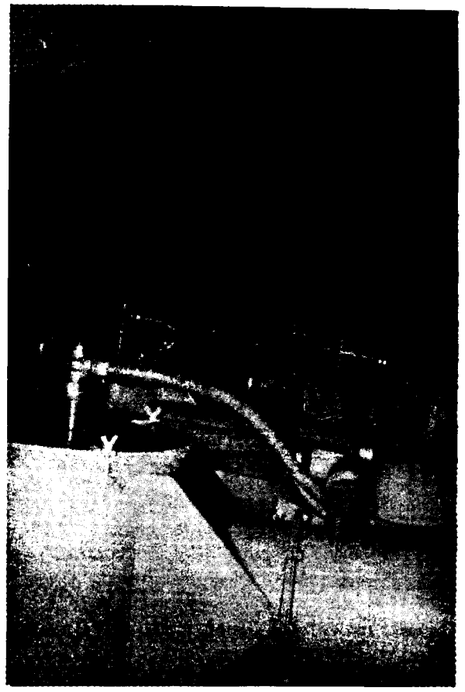


The Controls for the blasting manipulator are centralised at a single control panel. All equipment must break down to pass through 4' diameter cdits, hence use of flexible cables and hoses.

All coating application, except brush priming, was undertaken by hot spray. In the photograph can be seen the pressure pots and paint heaters for both primary and secondary coats. The smaller pressure pot contains heated solvent for pumping by pneumatic pump for gun and line flushing.

of a number of selected processes, in order to gain a better indication of the results that might be abtained in practice. Two 30′ long sections of 9′ 5″ i. d. steel tunnel lining were prepared by blast cleaning and coated with two systems.

Some months later, tenders were invited from a short list of coating manufacturers, each tenderer being asked to quote for two alternative systems. The Board awarded the contract to E. & F. Richardson Limited for the Adcora A3 coal tar/epoxy system referred to earlier. It is believed that they rejected the Neoprene system on the grounds of its somewhat higher cost.



Four Vacu-Blast Majorette machines are employed to undertake all the automatic and hand blasting. They are linked together and form part of the complete train.

E. & F. Richardson Limited nominated in their tenders their associate company Coating Contractors Limited as applicators.

Even before tenders were invited Coating Contractors Limited had given considerable thought to the most suitable method of blast cleaning and coating; the type of work and the area involved (nearly half a million square feet) immediately suggested some degree of automation, although in the early stages, open blast cleaning and manual spraying in adjacent separately air conditioned bulkheaded compartments were considered. These methods were subsequently abandoned due to the relatively low blasting rates that would be obtained and design difficulties in connection with dust seals and cantilevering of the bulkheads involved. It was finally decided to blast by a vacuum blasting process and a "train" for continuous operation was designed.

The blasting and coating "train", operating at

present at Ffestiniog, consists of the following components :—

A. A multistage transformer rated at 10 KVA and designed to transform an input voltage of from 320—440 volt three phase A. C. to a variety of output voltages. This transformer also carries all the switchgear and contactors for the electrical circuits within the tunnel.

B. Four vacuum blasting machines.

C. A blasting manipulator to obtain the travel on three vacuum blasting guns, the manipulator movement being itself powered by three ½ h. p. electrical motors.

D. The Spraying trolley attached the rest of the "train" is moved independently by winch, carrying two 5 gallon and one 2 gallon pressure pots, 2×KVA material heaters and a solvent pump, in addition to two specially modified spray guns.

The linear operating speed of the "train" lies between 60 and 150 feet per day. The sequence of operation for the complete process is as follows :—

SETTING UP

1. Two-tier pipe hangers are stud welded to the tunnel lining to support a 3″ steel air main conveying 525 c.f.m. of clean dry air at 110 p.s.i. and also to carry the electrical supply cable to the most distant point of working.
2. As necessary a dam is erected at the starting point to prevent the ingress of seepage water to the working area, the dam being drained through a plasticised P.V.C. hose by gravity.
3. The complete "train", weighing about 5 tons, is lowered by steel wire rope, employing a rope climbing hoist. (A great deal of the work is in slopes of 1 in 3).
4. The winch for use with a personnel and stores trolley is installed on foundations at the upper limit of working, to permit easy access to tke working face.
5. Plywood bulkheads are fitted at the upper and lower limits of working and inlet and exhaust ducting and manways are fitted. The inlet ducting is connected to a 25 h.p. 15,000 c.f.m. paddle bladed fan.

OPERATING

Blasting and spraying are continuously carried out in

Specially adapted spray guns are used for the hot spraying. The three lines consist of atomising air, fluid line and solvent flushing line. Thiokol and stainless steel braided P.T.F.E. hoses are employed.

The coated surface is marked off into squares of about four square feet; each square is checked for film thickness and holidays. Here an eddy current thickness gauge is being employed.

two shifts, night and day. The blasting crew are resposible for priming by brush and no blasted area is left unprimed for more than 25 minutes. Blasting is undertaken in 3′ wide circumferential bands, the whole " train " being winched upwards with the climbing hoist every 9 linear feet. The coating is applied manually by the hot spray technique, the nozzle temperature of the coating being in the order of 150°F. The coating is itself a catalysed material and has a pot life in order of 20 minutes at this temperature, and for this reason each gun is fitted with a solvent flushing circuit powered by a pneumatically operated pump. All materials and solvent hoses are in stainless steel braided P.T.F.E. The coating is applied in two coats giving a dry film build of 0.010″ per coat, each coat differing in colour.

INSPECTION

The inspection of blasting is undertaken minute by minute by the shift foreman at the controls of the blasting manipulator whilst frequent spot checks are made by the general foreman and site engineer. Badly scaled areas are double blasted by reversing the manipulator on completion of its travel, until only a dead white finish is obtained. The coating is inspected in lengths of about 500 linear feet in the following manner :—

1. For continuity with a wet sponge Holiday Detector employing a roller type electrode damped with distilled water, to which wetting agents and Fluorescine have been added. The areas inspected in this way can be readily seen. The Holiday Detector is itself a " fail-safe " type of instrument, giving a continuous high pitched note until discontinuity is detected.
2. For thickness by spot checks with magnetic thickness gauges and for a wider coverage with a pre-set eddy current type thickness gauge.
3. For cure with solvent dampened filter paper discs, secured to the surface with magnets.
4. For bond by destructive cross hatching (subsequently patches are made good by brush).

SAFETY

The necessity for safety precautions was evident from an early stage. A continuous gas detector is mounted on the spraying trolley at all times and sampling gas detectors are employed at possible danger points from time to time. The highest solvent concentration established to date has been 4½% of the lower explosive limited. CO2 fire extinguishers are carried on the " train " and the " train " itself is in direct communication to the site hut by field telephone. All hoisting wires are doubled with safety check wires are attached to expanding " A " brackets within the tunnel. All personnel wear rubber boots and safety helmets at all times and face guards for hand blasting and when working in pump legs on 1 in 1 slopes, all personnel wear life-lines.

An Inspector checks for continuity of the coating employing a fail-safe wet sponge holiday detector.

A view of the No. 1 tunnel portal area showing dismantling pipe which forms the access to 720 feet of penstock and 2,000 feet of steel tunnel lining.

PYE Television Microwave Link Equipment

TYPE PTC M1000

PYE Telecommunications Limited manufacture a comprehensive range of both portable and fixed station microwave equipment designed for operation on frequencies between 5925 and 7500 Mc/s.

The Pye PTC M1000 is a reliable long-range microwave equipment suitable for the transmission of monochrome video-signals simultaneously with high fidelity audio signals. 1 watt of output power ensures an effective communication distance of 50 miles or more under favourable path conditions.

Voltage stabilisation and temperature control maintain a stable frequency operation over a wide ambient temperature range.

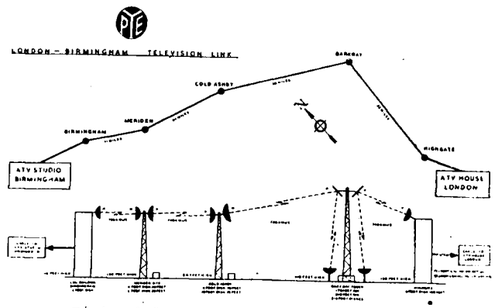
The equipment can be used back-to-back as a demodulating-repeater for short-haul multi-stage transmission distances. It can be supplied suitable for portable or fixed station applications. The portable equipment is housed in four luggage-type steel cases designed to afford maximum accessibility in order to facilitate maintenance and speed of assembly on site.

For fixed station applications the equipment is supplied with adaptors for installation in 19″ racks. A typical assembly is shown in the above illustration. Adequate space is provided in the equipment cubicle to accommodate additional rack mounting chassis units if required.

Pye Telecommunications' engineers have had extensive training and experience in microwave communications. They are ready to give every assistance in planning any system to clients' requirements.

DESCRIPTION

The Pye PTC M1000 Microwave Television Link Equipment provides one watt of transmitter output power for reliable TV relay service over ranges of 50 miles and more under favourable path conditions. High fidelity audio signals can be multiplexed with monochrome video for simultaneous transmission of audio and video signals. The need for telephone lines is thus eliminated, and remote pickup installations have complete physical freedom.



Path of Pye Microwave link... the new TV highway of the air.

The PTC M1000 can be adjusted to cover from 6575 to 7500 Mc/s. Models can be provided to cover the band from 5925 to 6425 Mc/s if required.

The portable version of the PTC M1000 requires only the four convenient lightweight packages shown in Fig. 1. Contained in luggage-type cases, these include the Transmitter Control Unit, the Transmitter RF Head, the Receiver RF Head, and the Receiver Control Unit. Such important elements as audio channels, r. f. wavemeters, testing and engineer's intercommunication circuits are all built into these four units so that accessories are not required. Maintenance and power demand of PTC M1000

Picture of a school in Swindon with modern water tower in the background, surmounted by the Pye dish aerial which is the receiving end of the microwave link.

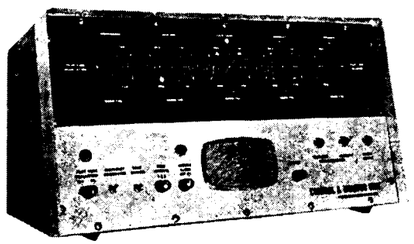
circuits are kept low by the use of a minimum number of low-cost, high-reliability valves.

The basic PTC M1000 system also includes two L-shaped mounting brackets and a Test Attenuator for interconnecting and bench-checking the Transmitter and Receiver. Complete Pye accessory equipment is available, including parabolic reflectors having two, four and six-foot diameters, aerial feeds with either horizontal or vertical polarization, tripods and tilt-heads, standard interconnection cables, etc.

TECHNICAL INFORMATION

Transmitter and Receiver portions of the PTC M1000 are shown in the block diagrams of Figs. 2 and 3. Demarcation between the control and r. f. units is indicated to show the physical location of adjustments and components.

High fidelity audio is carried from Transmitter to Receiver on a 7.0 Mc/s video sub-carrier. The audio frequency response is +0 dB and —3 dB relative to 1 Kc/s. from 50 to 15,000 c/s.



Control and monitor unit for microwave/ telemetry system.

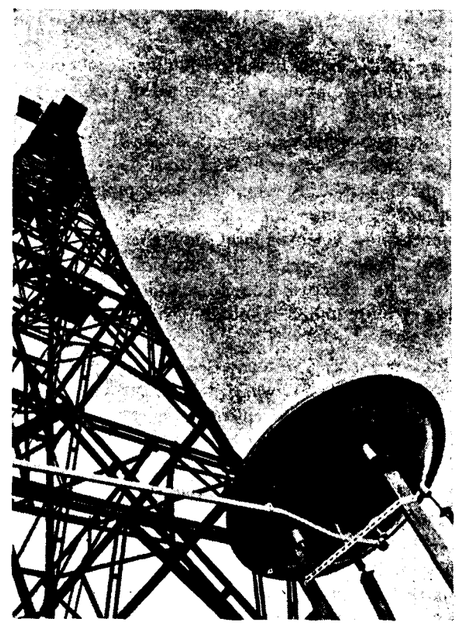
Special effort is made to hold the transmitter frequency well within the specified tolerances. This is done by temperature and voltage regulation of the transmitting Klystron. As shown in Fig. 4, the Klystron body temperature is maintained by thermostati control of the fan motor speed.

A simple gear mechanism is employed in the RF Head to tune the transmitting Klystron. This mechanism has a tuning rate of about 25 megacycles per turn, and facilitates smooth and rapid transmitter adjustment. A small light is mounted at the top of the Transmitter RF Head panel (Fig. 4) to facilitate night-time adjustment of the equipment.

As a test and service feature, a circuit which generates a sawtooth test signal is built into the Transmitter Control Unit. This signal can be switched in at the Transmitter Control, and can be used to tune the Receiver, check linearity, and set deviation. The Receiver a. f. c. circuit will also operate properly with this signal. The addition of the sawtooth generator solves a major operational problem—that of checking the microwave system when no external video signal is available.

For further convenience in equipment checking, monitoring jacks are provided at both the RF Heads and the Control Unit, and test meters are built into the Control Units. Provision is made for metering the monitor crystal current. This is of particular value in initially tuning the Klystron and in monitoring frequency and relative power output. Engineer's intercommunication circuits are also provided between the Control Units and the RF Heads for use with sound-powered telephone equipment.

The PTC M1000 circuits can easily be adjusted and serviced while on the air. Figs. 4 and 5 show the Transmitter RF Head and Transmitter Control Unit



London to Birmingham T.V. link... Parabola and passive reflector at Barkway

with access covers removed. The hinged panel of the Control Unit of Fig. 5 allows additional freedom in the adjustment and maintenance of circuits and the replacement of components. When operated in a protective shelter, PTC M1000 Control Units can be removed from the carrying case and mounted in a standard 19-inch rack.

An RF Head and its Control Unit can be connected by up to 200 feet of cable. An adjustable compensation is provided to equalise the effect of cable length. In the PTC M1000 Receiver, balanced push-pull video signals are used to cancel out stray interference pickup in the r. f. cables between the Receiver Head and the Receiver Control Unit. As the result of careful circuit design and the use of a low noise mixer crystal the Receiver noise figure is less than 13 dB.

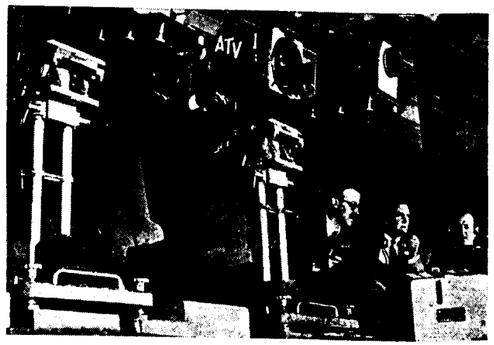
Through the use of a waveguide adapter, it is possible to locate the portable RF Heads indoors and run the waveguide to an aerial mounted outside. The use of a ferrite isolator at the Transmitter RF Head permits the aerial to be located up to 100 feet away.

PYE MICROWAVE LINK EQUIPMENT

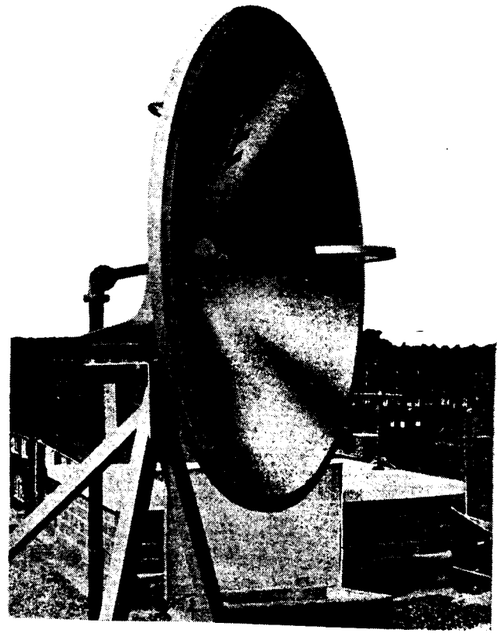
Among the many popular equipments manufactured by Pye Telecommunications Limited of Cambridge is a comprehensive range of both portable and fixed station microwave equipment designed for operation on frequencies between 5925 and 7500 Mc/s. The Pye PTC M1000 is a reliable long-range microwave equipment suitable for the transmission of monochrome video-signals simultaneously with high fidelity audio signals. 1 watt of output power ensures an effective communication distance of 50 miles or more under favourable path conditions.

For instance, young artists can rehearse in a Birmingham studio while top theatrical producers watch their every movement on a screen in London. This was made possible by the completion early in 1960 of a Pye 7000 Mc/s television microwave link, which carries vision and sound programmes, for Associated Television Limited of England.

The link transmits television programme material from the 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



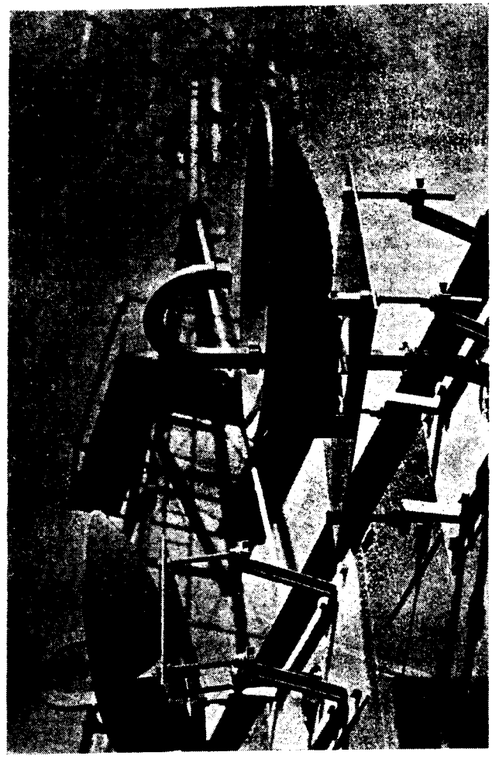
A typical ATV studio.



PARKNORTH Infants School Swindon Close up of typical microwave aerial.

receiver terminal at Highgate, London ... an overall path length of some 135 miles.

The longest hop (approximately 52 miles) is from Cold Ashby to Barkway. To achieve comparable signal to noise ratio figures a 10 ft. parabola on top of an 80 ft. tower at Cold Ashby is used, beamed to

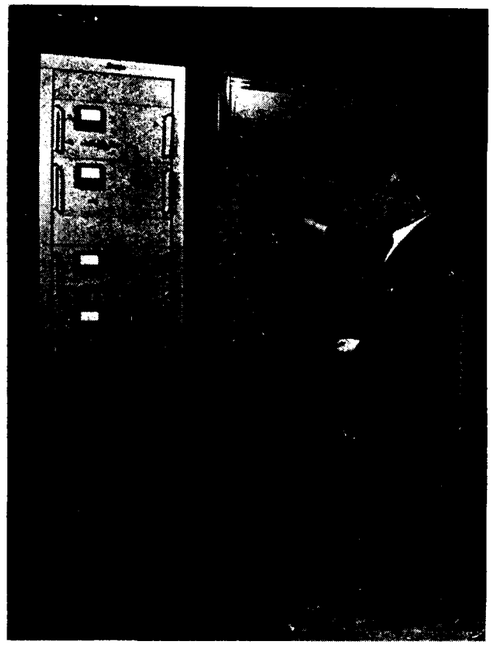


On a hill above Swindon, an old Water Mill now boasts a tall aerial array in place of its sails and on a small building at the base are mounted two 2-foot parabolic dishes which are the Pye Microwave Transmitters.

an 8 × 12 foot passive reflector 200 feet up on the tower at Barkway.

The microwave equipment is fully duplicated with automatic changeover to standby equipment in the event of failure. A Pye U. H. F. link is used on a time sharing basis for both Engineers' and Telemetry channels. On a mimic diagram the exact condition of the link is shown by the telemetry equipment, i. e. which individual units of the link are in use, whether transmission is being received in London and indicating failure in the public electricity supply at any of the terminals or repeaters.

Pye microwave links are used by many television authorities both in England and overseas as well as by a number of civil service establishments.



PARK NORTH Infants School Swindon. Micro-Link receiver and modulator. The latter connects the received channels, 5 and 10, to channels 1 and 2 (of band 1) and is supplied to subscribers on the wired system. Mr. L. King engineer in charge of complete installation.

PYE IMPROVES THE PICTURE

Pye Microwave is also extensively used to improve the picture in television fringe areas and one such system was installed in Swindon, England, some time ago. This town is about eighty miles from the nearest Television Transmitter and also lies in a hollow so that signal levels are low even with the most sensitive aerials and receivers and pictures were invariably poor.

A scheme to overcome these difficulties was planned by the Engineering Division of a local firm, Relay Exchanges Limited, in conjunction with Pye Telecommunication engineers. By use of special aerials and receivers first class sound and pictures are received from both the British Broadcasting Corporation and the Independent Television Authority at a site overlooking the town. The received signals are then fed to Pye Microwave Transmitters and

The New Copperad Fan Convector

THE firm of Copperad, Ltd., which was founded in 1933 and operated originally as the British Unit Heater Co., is one of the largest privately owned companies in the U K. manufacturing heating, ventilating and cooling equipment. The company's headquarters are on a 9-acre site at Colnbrook, Bucks., and incorporate a subsidiary company, Manwood Miller Fans & Filters, Ltd. In addition, there are factories at Sunbury-on-Thames and Stalybridge (Cheshire), the total labour force for the group being over 500. Unit heaters have been made by the company since its inception ; fan convectors and coolers were introduced in 1950, and Raystrip and Copperad radiant heating panels in 1954. Two other products of wide appeal, Wallstrip and Sil-line heaters, followed in 1957 and 1958, and were so successful that a " crash " building programme for a 20,000 sq ft extension to the Colnbrook factory was necessary in 1959 to meet the demand. For this extension, the first sod was dug by Bernard Miles on May 19, 1959, and the factory was completed and occupied just six weeks and three days later. Copperad products cater for the heating, by steam or hot water, of buildings of all types; i. e., houses, offices, shops, schools, churches, factories and other industrial premises.

THE NEW COPPERAD FAN CONVECTOR

It was ten years ago that Copperad first introduced the term " Fan Convector ". The unit described was quite revolutionary in that it incorporated such ideas as the replaceable Unit Fan/Motor Assembly, Inbuilt Thermostatic Control, Dual Speed Motors and Automatic Speed Control. Many of these developments have of course now become universally adopted.

(Continued from page E.15)

diplexed into a common aerial system, comprising two 2-foot parabolic dishes, one of which is beamed to the Walcot Park South and Park North Housing Estates in Swindon.

At the housing estate the Pye Microwave Receiver, consisting of a 4-foot parabolic dish, common to both RF channels, is located on top of a Water Tower. Signals are fed to separate receivers and the video and sound outputs from these Microwave receivers are then ' piped ' into the houses. No individual aerials or special television sets are required by the subscriber, the video and sound signals being fed into his set by special ccaxial cable and for a cost of only two shillings per week, interference free viewing is assured.

Booster television and radio services are provided in other parts of the country by means of high aerials and repeater stations but it appears that the microwave techniques are much to be preferred.

FURTHER DEVELOPMENT

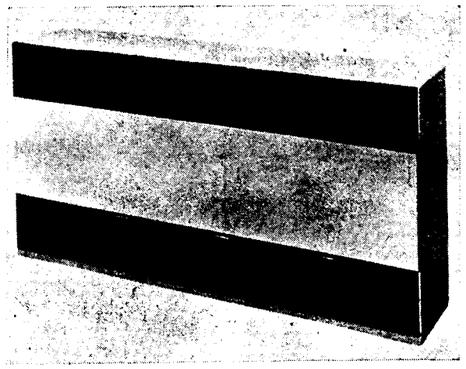
Other microwave systems for the transmission of up to 240 telephony channels have now been developed and these provide reliable communication over hundreds of miles. The appartus will operate in conjunction with channelling equipment, designed to C. C. I. R. recommendation, in the SHF frequency band from 5925 to 7450 Mc/s.

Flexibility has been the keynote in design so as to meet the varying and exacting demands of the user. Waveguide diplexers have been incorporated to allow the simultaneous transmission and reception into a common aerial whilst maintaining adequate isolation between the transmitter and receiver units. The equipment can be fully duplicated with automatic changeover, or partially duplicated using one standby channel which can be switched automatically to replace a faulty link in either direction.

Whichever scheme is adopted a monitoring system provides continuous indication at the terminal stations of the serviceability of both main and standby equipment. The size of the parabolic dishes required depends on path length and 2 foot, 4 foot, 6 foot and 10 foot dishes are available with all the necessary ancillaries.

Pye microwave equipment is also particularly suited for the transmission of radar intelligence to control stations remote from the radar sites.

Since the introduction of the Unit the company's research and technical resources have constantly examined the possibility of improvement and development. This research has culminated in the production of a new model, the Mark IV. This new model is first and foremost the thinnest Fan Convector available being under 9" from front to back. It has three speed motors, inbuilt individual automatic time control, automatic temperature control as well as automatic speed control. All round air diffusion is attained by the use of left and/or right or up or down according to the particular requirement.

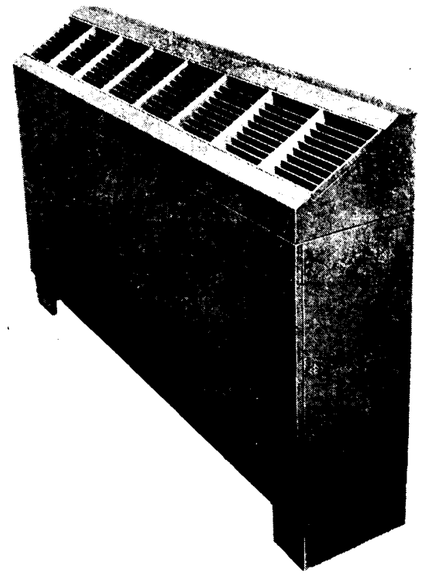


Yet Another Model Copperads' " Fan Convector "

There are four distinct models. The first of these is the Basic (Type B). This as the name implies is a skeleton type unit intended for incorporation in builders work cabinets. The type is available in two styles with Top Outlet (Style BT) and Front Outlet (Style BF). Style BT has spigotted openings in the top of the casing and has its air outlet vertically upwards whereas Style BF is fitted with a top casing section with a spigotted outlet arranged to provide horizontal air discharge through a wall on the same side as, or the opposite side to the access panel.

The second model is the Standard (Type S). This is a free standing cabinet complete with switchgear and inlet and outlet grilles. Grilles for recirculating air inlet are provided at the bottom front of the casing, or if specified the unit can be arranged for the fresh air inlet either at the rear or the base. The model is available in two styles, Top Outlet (Style ST) having air discharge at the top—upward, or Front Outlet (Style SF) with the air discharge at the top front—forward.

Plinth (Type P), the third model. This cabinet is of the free standing type but is mounted on a plinth and has its recirculating air inlet through the base. The model is available in two styles, Top Outlet (Style PT) and Front Outlet (Style PF) with air discharge director.



A Model of Copperads' " Fan Convector "

Extended (Type E). This type has, as the name implies, an extended cabinet giving a forward air discharge at high level (overall height 7' 7"). It is complete with grilles and switchgear and is arranged with the recirculating air inlet at the bottom front of the casing or fresh air can be introduced at the rear or base of the case. The cabinet is in two styles, Fixed Grilles (Style EFG) or Loose Grilles (ELG).

The many new features incorporated in the new range of Copperad Fan Convectors have considerably widened the number of applications. Centrifugal Fans permit operation against greater resistance, bringing forced ventilation to a wider variety of applications, allowing also the incorporation of filters, with a minimum reduction of air volume and thermal emission.

The idea of two speed motors introduced more than a decade ago has now been developed, and three speed motors are now offered as standard. The

two lower speeds (Normal and Low) are suitable for the majority of applications, and the low speed is recommended for installation in schools, churches and other similar buildings where quietness is essential. The Super Speed is especially offered for use in buildings where rapid warming up in the morning is desirable prior to occupation.

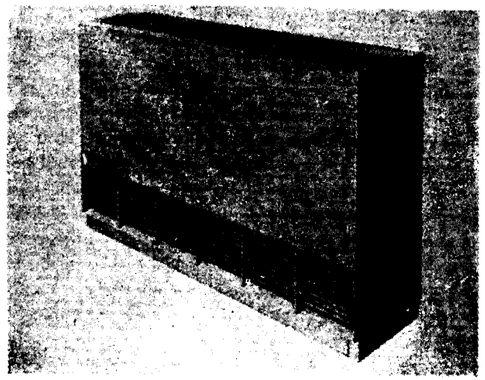
As an optional extra, a specially designed room thermostat (Suffix T1) can be inbuilt and integrally wired into the cabinet. This thermostat provides On/Off control for the motors at any predetermined temperature on both normal and low speeds. The adjusting knob with temperature scale is conveniently located at the top of the cabinet.

If the cabinet is connected to fresh air or is " ceiling mounted " this inbuilt theromstat cannot be fitted since it would not react correctly to the recirculated room air. It should be mounted externally to the cabinet.

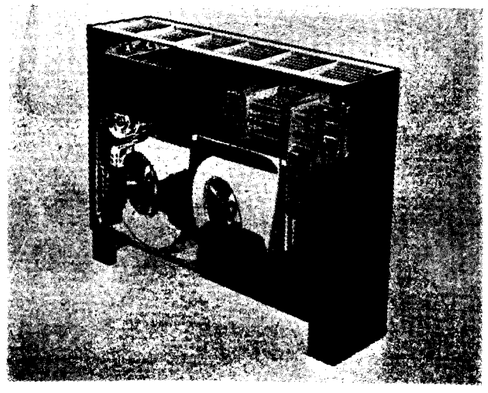
As a further optional extra, an additional thermostat can be similarly provided. As standard it is wired to provide automatic speed change from Normal to Low Speed or vice versa (Suffix T2). Normally this thermostat would be set to give this speed change at a temperature say 5°F or 10°F below the temperature set for On/Off control. If especially ordered, the wiring can be so arranged as to give speed change between Super and Normal Speed (Suffix T3). As with thermostat T1 it is not available with fresh air inlet or ceiling mounting. This thermostat should be pre-set at the time of installation for the desired speed change temperature. Access for adjustment is through the main front panel.

All types, Basic, Standard, Plinth or Extended are supplied in four cabinet sizes which vary only by length. The height and depth wall to front remaining constant according to the type in question. Each type can be supplied with either one, two or three row heat exchangers but these do not affect in any way the external dimensions. The lengths available are :—

Model References (Standard Type)	Length, Inches
ST or SF 124, 124S, 224 or 324	24"
ST or SF 136, 136S, 236 or 336	36"
ST or SF 148, 148S, 248 or 348	48"
ST or SF 160, 160S, 260 or 360	60"



Another Model of Copperads' " Fan Convector "



Interior view of Copperad's " Fan Convector "

The standard arrangement of switchgear and water connections is that the switchgear is on the left and the water connections on the right when facing the front of the unit. If this arrangement is not convenient the cabinet can be turned around and the front panel grilles removed and put on the other side, similarly with the rear panel. This reversible cabinet principle is a very convenient way of handing the cabinet with a minimum of alteration.

It will be seen from the emission table that the large overall reduction in size has not reduced the units efficiency. The heat emission (B. T. U.'s/hr) and air volume (C. F. M.) is the same for all four types, that is of course using the same number of rows of heat exchangers of the same size.

X-ray determination of element distribution in ultra-microsamples

BY S. A. BURGEN, MBE, AMIEE
Chief Development Engineer, Cambridge Instrument Co. Ltd.

X-ray microanalysis has established itself firmly and rapidly in the last few years. The author indicates the potentialities of the method and describes some recent applications to analytical problems.

METALLURGICAL research in recent years has produced results suggesting that small variations in composition from point to point alter the properties of an alloy in a drastic manner. It had been suspected that the concentration of an element might change by a large factor over a distance of a few microns—thousandths of a millimetre—but no method existed that would display the distribution of components of such a small amount of material. Chemical and orthodox spectroscopic analyses require samples many times larger than this, and hence provide information only on the average or bulk composition. Microscopic examination of polished and etched samples of metal, by optical or electronic microscopes, provides a great deal of information on the appearance of particles, but no positive identification of elements was possible on this scale. What the metallurgist required was an instrument which would (a) positively identify elements in very low concentrations; (b) measure the concentration of these elements in any given cubic micron of a sample; and (c) display the distribution of a selected element in such a manner as to permit correlation with the picture seen in his optical microscope. These requirements are satisfied by the X-ray scanning microanalyser.

PRINCIPLE OF OPERATION

The principle of operation is shown in Figure 1. A heated tungsten filament acts as a source of electrons, and these are focused by the condenser and objective lenses into a spot less than one micron in diameter on the surface of the specimen. By means of the scanning coils, this spot is made to scan an area which may be up to 0.5 mm square. The electron gun, column and specimen are maintained at high vacuum.

ELECTRON IMAGE

Some of the electrons striking the specimen are back-scattered, and a proportion of these strike a phosphor disc mounted close to the specimen on the end of a Perspex light guide. This causes the phosphor to scintillate, energising a photo-multiplier at

(Continued from page E.18)

Emission—low temperature hot water

B. T. U.'s PER HOUR

	24 inch			36 inch			48 inch			60 inch		
	Super	Normal	Low	Super	Normal	Low	Super	Normal	Low	Super	Normal	Low
2 Row	11600	9800	8000	24800	20700	16800	38000	21900	25600	49200	40700	32800
3 Row	15600	13100	10600	31400	26000	20900	46200	38300	30800	62000	51700	42000

170°F Mean with a 20°F drop and with an air entering temperature of 60°F

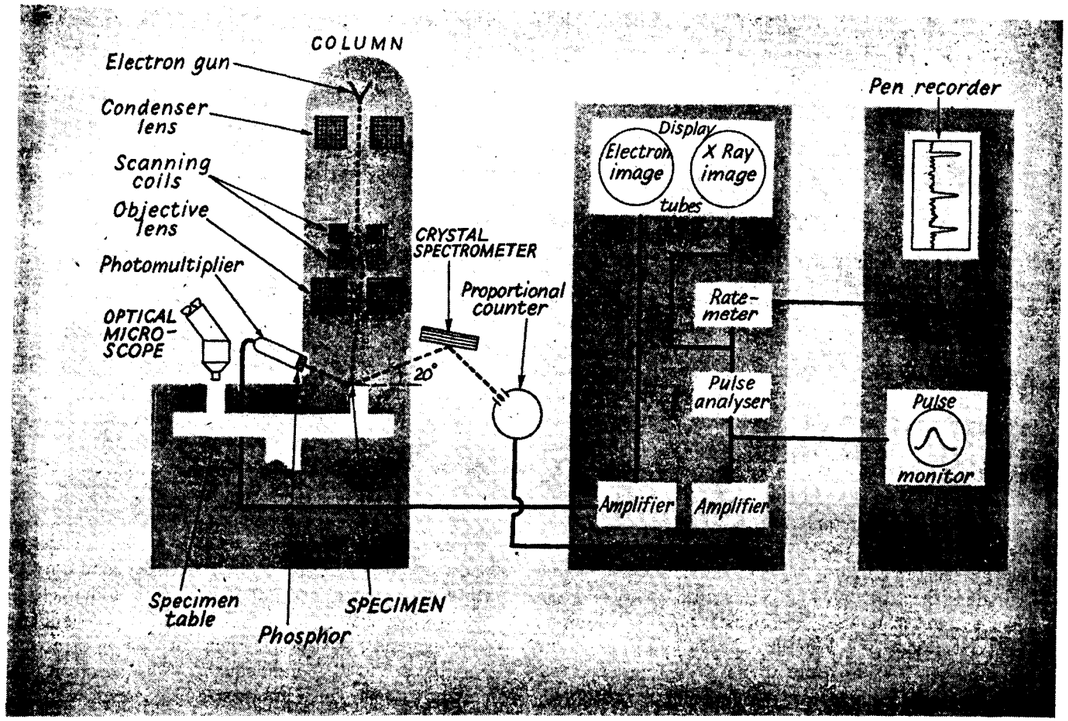


Figure 1 : The general arrangement of the X-ray scanning micro-analyser. The specimen table rotates so that the specimen can be transferred from the electron beam to a position where it can be viewed by the optical microscope.

the other end of the light guide. The resulting signal is amplified and is used to modulate the brightness of a cathode-ray display tube. The beam of this tube is arranged to scan in synchronism with the electron beam probe, producing an image—rather similar to that of a television set—which represents the surface features of the sample and is very like that seen through an optical microscope.

Since heavy elements back-scatter more electrons than light elements, the image, in addition to giving topographical detail, also discriminates by atomic number. This information is invaluable as a preliminary to analysis.

X-RAY IMAGE

Electrons from the beam also enter the surface of the specimen and excite X-rays. Some of this X-radiation strikes the surface of a curved crystal in the spectrometer and is reflected. As with optical diffraction, the angle through which the radiation is turned depends upon its wavelength. Since each element emits a characteristic wavelength, this provides a convenient means of separating the radiations from each element present in the sample, so that they can be measured individually. The crystal is arranged to rotate relative to the incident X-ray beam, thus permitting radiation of a selected wavelength to be directed into the proportional counter, where its intensity is converted into an electrical signal. The output from the proportional counter is amplified and is used to modulate the brightness of a second display tube, again scanned in synchronism with the electron beam. The brightness of the image in this case is related to the concentration of the selected element in the area examined.

Two displays are thus provided side by side, one a magnified image of the area being scanned and

providing detail of its physical structure, the other corresponding with the first point by point and showing the distribution and concentration of the selected element in this area.

The magnification of the images can be varied from 200× up to 2 000×.

OPTICAL MICROSCOPE

A binocular optical microscope is mounted on the specimen chamber, and provision is made for moving the specimen from the optical axis to the equivalent position under the electron axis. Preliminary examination and location of the field of interest can thus be carried out as in normal metallography.

QUANTITATIVE ANALYSIS

Quantitative analysis is carried out by passing the pulses from the proportional counter to a ratemeter. This provides an average analysis over the area being scanned. A spot analysis can be carried out by stopping the scan and positioning the probe with reference to the image persisting in the afterglow of the display tube. The volume analysed in this case is approximately one cubic micron. In either case, the instrument is calibrated by reference to a sample of pure material, and an accuracy of plus or minus one per cent can be achieved. The mass sensitivity is the highest of all X-ray analysis methods : typically a mass of 10^{-14} gm of copper can be detected.

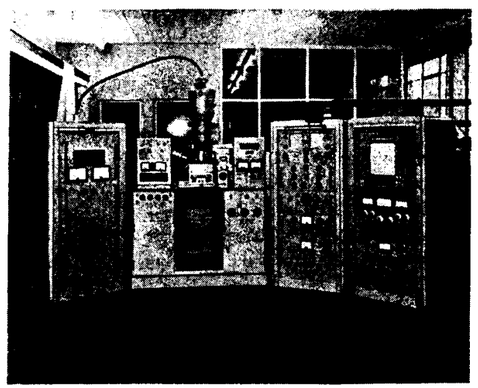


Figure 2 : The instrument itself, with its associated power supply on the left and the display and recording cabinets on the right.

Accuracy is maintained at low concentrations by passing the pulses to a scaler, the counting time being extended as the pulse rate falls off.

The spectrometer can be motor-driven in synchronism with the chart of a recorder driven by the rate-meter, to provide a spectrum of the composition of the sample. Alternatively, the whole of the X-ray beam may be directed into the proportional counter without being dispersed by the crystal. Since the pulse height of the output signal is proportional to the quantum energy of the X-rays and some of these are characteristic of the element, the analysis can be carried out by means of a pulse height analyser.

Provision is made electronically for superimposing the X-ray image on the afterglow of the electron image to provide accurate correlation between them. A slow line scan is provided, displaying on the tube the concentration of a selected element along any line on the surface of the specimen.

THE CAMBRIDGE X-RAY SCANNING MICROANALYSER

A photograph of the instrument is shown in Figure 2, the column mounted on its desk occupying the central position. The EHT supply for the electron gun is contained in the rack on the left of the picture, and the display tubes with their associated circuitry, X-ray measuring and recording equipment in the racks on the right. The camera is shown in its mounting above the X-ray display tube.

The specimen is carried on a stage shown partly withdrawn from the base of the column in Figure 3. It can be traversed orthogonally by external controls, and rotated about its own axis. The stage itself can be rotated to move the specimen from the optical to the electron axis, and is fitted with mechanical stops to ensure correspondence between the two positions.

The stage also carries 14 stations for pure samples of iron, nickel, tin, copper, zinc, *etc*, for calibration purposes when making a quantitative analysis. An air lock is mounted on the specimen chamber, to the right of the optical microscope, to permit changing specimens without letting the column down to atmospheric pressure.

The spectrometer is mounted immediately to the right of the column and can be fitted with four crystals, any one of which can be brought into the operating position by an external control. A sealed

proportional counter, xenon-filled with a 0.005 in beryllium window, is supplied for use in analysing heavier elements, and an argon flow counter with a 6 micron Mylar window is provided for the lighter elements. (The lower limit at present is at magnesium with an atomic number of 12.) The spectrometer can be operated in air, backing pressure or high vacuum, as required.

SOME APPLICATIONS OF X-RAY ANALYSIS

The microanalyser has already provided a great deal of new and significant information. One example is the work done by Dr. Melford to explain the appearance of cracks in hot pierced steel billets when other methods had failed to produce any direct evidence. Orthodox chemical analysis indicated that the concentration of copper—present in all steel made from scrap as a " tramp " impurity—was about 0.2 per cent, a normal amount. Preliminary tests with the microanalyser, however, showed immediately that in regions of a few microns adjacent to the crack the figure was nearer 25 per cent. Further work disclosed other tramp impurities in concentrations much higher than had been previously detected, and established their spatial distribution in the steel with a discrimination of a micron. These localised enrichments were the cause of the cracking ; the results were unambiguous and were obtainable by no other method.

The photographs in Figure 4 show how oxidation of mild steel causes selective removal of iron and produces a sub-scale enriched in nickel, copper and tin. The optical image corresponds closely to the electron image which, however, gives more information on surface relief—the region around the crack can be seen to stand out. The three dust particles indicate the great depth of focus, and their shadows show how much topographical information is present in this type of image.

The normal chemical analysis of the material gave a composition of nickel 0.14 per cent, copper 0.20 per cent and tin 0.059 per cent. The iron distribution can be seen to correspond to the optical and electron images. The nickel concentration, however, is much higher along the sub-scale than elsewhere, instead of being distributed evenly through the material. The maximum copper concentration also occurs along the sub-scale, but in discrete regions rather than continuously as with the nickel. The tin enrichment is associated with those regions richest in copper, but is in lower concentrations.

It can also be seen that the proud area around the crack is rich in both nickel and copper. This suggests that this region would contain material much harder than the matrix, causing relief polishing in the

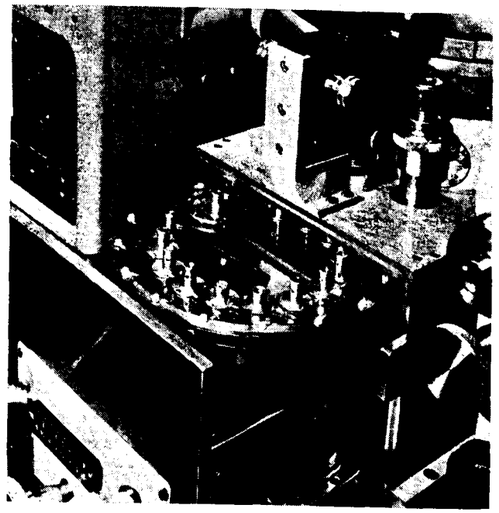


Figure 3 : The specimen table. In addition to the rotational movement which transfers the specimen from the electron axis to the optical axis, the specimen can also be moved orthogonally by external controls. Apart from the specimen itself, it is possible to mount 14 separate elements for calibration.

preparation of the sample. Microhardness tests have confirmed that this was the case.

These photographs display the distribution of the elements in question in a semi-quantitative fashion on a microscopic scale. The next stage is to position the probe on the points of interest thus revealed ; for example, on the brightest points of the copper or nickel X-ray images. Using the quantitative analysis technique already described, the concentration of the elements at these selected spots can be rapidly determined. These two types of investigation, carried out on the same instrument, provide complete quantitative and qualitative information on the distribution of selected elements over very small areas of the sample ; the volume of material involved in the spot analysis may be as low as one cubic micron, and a copper content of 0.05 per cent in this region can be detected.

AN APPLICATION IN BIOLOGICAL RESEARCH

Some interesting biological work has been carried out by Dr Switsur in the Cavendish Laboratory at Cambridge. Figure 5 shows the calcium and iron X-ray images of a section of tooth, an upper incisor of a rat. The recording above each photograph represents the intensity of radiation, and hence the amount of the selected element present. Calcium can be seen to be distributed throughout the enamel and the dentine, but a sudden reduction in concentration can be seen in the recording. This point is the junction between the enamel and dentine, and it is clear that the calcium concentration in the former is much higher. The concentration in the dentine, while lower, is still much higher than would be expected. The iron X-ray photograph is of great interest, as it shows the existence of a very thin layer of iron on the outer surface of the enamel. The height of the peak of the iron record represents a concentration of 7.5 per cent and its distribution can be seen from the photograph.

THE PATTERN OF PROGRESS

The impact of this new tool on the field of research may be judged by the world-wide response to its appearance. Orders were received before the commercial design was completed, and production programmes were revised twice, laying down an initial quantity of 30 instruments, before the first microanalyser was delivered to the Atomic Weapons Research Establishment in May 1960. Users in Britain also include university and industrial metallurgical and chemical research laboratories, and orders have been placed by steel, non-ferrous metal, glass, oil, cable and electrical manufacturers in Britain, Europe and the U. S. A. Production, currently running at one per month, is scheduled to increase to twice this figure.

Because of the pressing problems, many involving large sums of money, in the technology of metals and alloys, the initial work has been mainly in this field. The cost of constructing the Tube Investments instrument has been amply justified by the savings already effected within the Group as a result of the information it has provided.

But the microanalyser can operate on any solid sample whose surface is conducting or can be made so by aluminium evaporation or similar processes. The sciences of mineralogy, biology, biochemistry, ceramics and semi-conductors are also fields in which

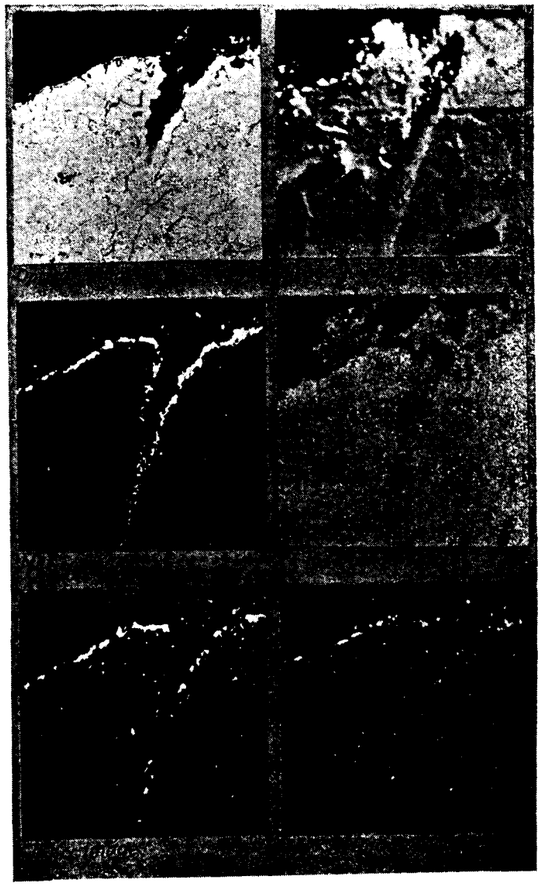


Figure 4 : This series of photographs concerns a specimen of oxidised mild steel. The four lower images, each of which relates to a specific element, can be related to the conventional optical and electron images at the top. They reveal the distribution of elements and provide the necessary knowledge for planning quantitative measurements in particular regions.

hitherto unobtainable information has been provided by the technique, and first results indicate the need for further work in these fields.

Phenomena regarded as of passing interest in the rapid initial development, such as the modulation of the electron image by voltage gradients across a semi-conductor junction, may turn out to be of lasting importance. The low level of energy received by the specimen from a scanning probe as compared with the

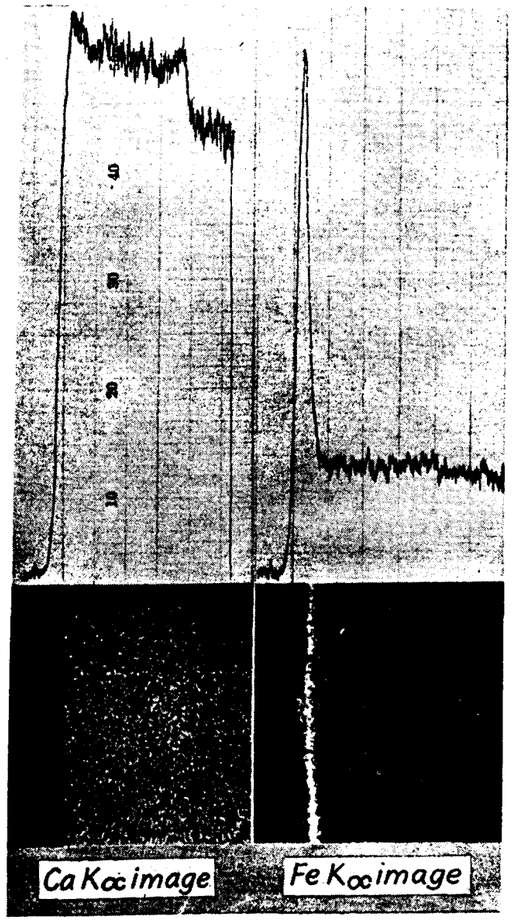


Figure 5 : These records were obtained in the analysis of a rat's tooth at the Cavendish Laboratory. The upper traces indicate the intensity of radiation and hence the quantity of that element which is present. It can be seen that the photographic images give a reliable guide to those quantities.

electron beam of a transmission electron microscope permits examination of specimens that the latter technique would destroy, and points to a new field in fragile fibres, organic materials and biological sections. Results obtained in these areas by research students in the Engineering Laboratory at Cambridge indicate wider use as a high resolution scanning electron microscope for surface topography as well as for elemental analysis.

X-RAY MICROANALYSIS

In 1951 Professor Castaing of the University of Paris described in his doctoral thesis a technique of X-ray emission point analysis, using an electron beam probe. At about the same time, MacMullen, under Professor Oatley in the Engineering Laboratory at Cambridge University, constructed a scanning electron microscope, while in the Cavendish Laboratory, Nixon, under Dr. Cosslett, developed the point source X-ray microscope. These last two instruments were not analytical but they embodied display and electron optical systems similar to those described.

In 1956 Duncumb in the Cavendish Laboratory, again under Dr Cosslett, embodied features of all three techniques in a new instrument which was the first electron probe X-ray scanning microanalyser.

Dr. Duncumb then collaborated with Dr. Melford of Tube Investments Research Laboratories in the design and manufacture of an instrument specifically for metallurgical research. This instrument was the basis of the "Microscan" manufactured by the Cambridge Instrument Co, the first production instrument being shown at the Physical Society Exhibition in London in January 1960.

The mass of accurate data on the microscopic scale which can now be turned out so rapidly may be not without impact on theory in fields where experimental results have not so far been available to check it.

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The Horstmann 'TIMESTAT' Model 'B' (Electric)

THE new Horstmann 'Timestat' has been designed to meet the demands of timeswitch specifications calling for irregular and complex switching schedules and its flexibility completely surpasses that of any available conventional timeswitch.

It has been designed primarily for the control of space heating and it can be used in conjunction with standard control systems to programme electric, gas, oil or solid fuel space heating.

The Unit consists of a movement making one revolution in seven days, fitted with a PATENT SEVEN DAY DIAL. Each day of the week can, therefore, be individually programmed to the exact switching requirements for that particular day. The large diameter dial is engraved with days and hours and the operating tappets consist of cam segments which are built up to provide a continuous cam form for the particular switching schedule required.

These segments are held in place by clamps secured by knurled nuts on the rear of the dial. The operations for each day are clamped independently so that alteration of one days schedule can be achieved without disturbing the remainder of the weeks schedule.

All dials are interchangeable and are easily removed, so that dials set up in a workshop can be changed on location, achieving a change of schedule without loss of continuity of operation.

A completely overriding ON and OFF manual control is fitted. This manual operation is independent of dial operation and thus the sequence remains unchanged for the return to 'Automatic' control when desired.

The Timestat is available with either synchronous or electrically wound clockwork movements ; also synchronous movements with spring reserve. The whole Unit is fitted into an aluminium box, the cover of which is fastened by a cam latch which can be locked and sealed.

Two models are already available :—

5 amp—250 volts A. C.
20 amp—250 volts A. C.

No space heating schedule is too complicated for the new Horstmann electric "Timestat". Electric, gas,

(Continued from page E.24)

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[Courtesy : RESEARCH & DEVELOPMENT]

oil, or solid fuel fired systems—you can have them all under perfect control *every hour of the day* for a week at a time. On Monday, perhaps, you may want the heat on all day ; on Tuesday from 10.30 a. m. to 12.30 p. m. and 2.00 p. m. to 4.30 p. m. ; on Wednesday from 6.30 p. m. to midnight .... and so on throughout the week. With a " Timestat " all you have to do is programme each day's switching requirements on the patented seven day dial at the beginning of the week and then put time right out of your mind. The high quality movement of the " Timestat," which makes one revolution every seven days, will carry out your schedule exactly as you planned it.

The new Horstmann " Timestat " is invaluable for the control of space heating in churches, church halls, clubs, waiting and reception rooms, lecture halls, boardrooms, shops, assembly halls, dance halls, canteens, theatres, cinemas—in fact any place where heating is used irregularly throughout the week.

Typical 'TIMESTAT' Schedule for Church Hall Heating

SUNDAY	ON	OFF
	10.00 a.m.	*10.00 p.m.*
MONDAY	*8.30 a.m.*	*12.30 p.m.*
TUESDAY	*2 00 p.m.*	*10.00 p.m.*
WEDNESDAY	*8.30 a.m.*	*12.30 p.m.*
	2.00 p.m.	*6.00 p.m.*
THURSDAY	*12.00 noon*	*4.00 p.m.*
	6.00 p.m.	*11.00 p.m.*
FRIDAY	*8.30 a.m.*	*12.30 p.m.*
	5.00 p.m.	*11.00 p.m.*
SATURDAY	*8.00 a.m.*	*12.00 noon*
	3.30 p.m.	*11.30 p.m.*

THE MOVEMENT

The timeswitch is available with either synchronous or electrically-wound clockwork movements : also synchronous movements with spring reserve and 15-day and 40-day hand-wound movements. These movements are simple developments from the well known standard range of " large " movements as fitted to the Type V Mk, 11 timeswitch.

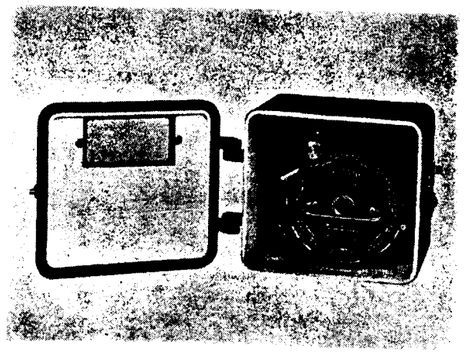
THE DIAL

The large diameter dial (4 inches) is engraved with days and hours ; a. m. and p. m. are also indicated. The figures and divisions are in white on a matt black ground.

The operating tappets consist of cam segments which are built up to provide a continuous cam form for the particular switching schedule required. Once set this cam form can be visually checked with the greatest of ease.

The cam segments are available in three standard values, 1 hour, with operating slope, and 1 hour and 4 hour maintaining segments. Special cams can be cut to order. A 1 hour period is required between an " off " operation and the subsequent " on " operation.

The segments are held in place by clamps secured by knurled nuts on the rear of the dial. The operations for each day are clamped independently so that alteration of one day's schedule can be achieved without fear of disturbing the remainder of the weeks schedule. The dial is easily removable to facilitate setting.



All dials are interchangeable, so that dials set up in a workshop can be changed on location, achieving a change of schedule without loss of continuity of operation, or the awkwardness of setting a dial on location.

MANUAL OPERATION

A completely overriding " on " and " off " manual control is fitted. This manual operation is independent of dial operation and thus the sequence remains unchanged for return to " Automatic " control when desired.

CAPACITY

Two models are available. :—

5 amp	250 volt A. C. only.
20 amp	250 volt A. C. only.

The new Kloeckner-Moeller-Push-button-Program

THE old push-button-program supplied unchanged for so many years by M/S Kloeckner-Moeller GmbH, has been improved last November. Hereby they were mainly guided by technical and aesthetic considerations.

It was possible, however, in spite of the changes, to maintain the various basic dimensions so that the changeover from the old to the new types can be undertaken without any difficulty by the customers.

The new line of contact blocks, push-buttons, as well as single- and multi-push button units has one characteristic in common : all devices are totally insulated. Therefore when mounted no extra protection, as commonly practiced with metal-clad devices, is necessary. Furthermore, no fault voltage can be transferred from one part to the other.

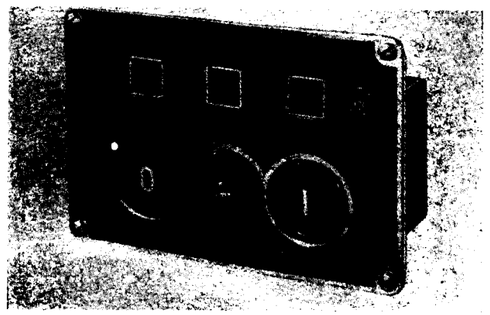
A chromium-plated frontring for the push-button, a design imbued with essentiality and purity of form, decorative nameplate for enclosed push-button units, and legend plates in various colours, lend a handsome appearance to these devices.

The various combinations and grouping (up to 24 units), in addition to the possibility of a quick change from one to another form within surface mounting, flush-mounting, and built-in devices, allow numerous variations as regards assembly, shape, and size.

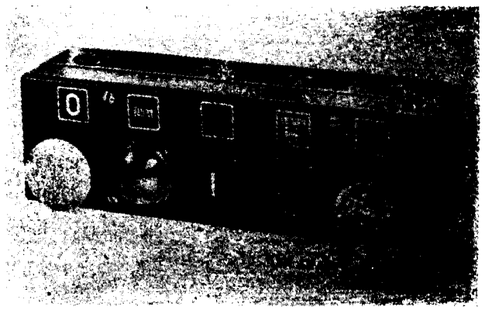
Maximum three contact-blocks can be assembled in tandem-formation. Their addition to an existing push-button unit at a later date on site is possible.

Replaceable legend plates on the push buttons and additional nameplates make every desired marking possible.

A transparent cover as extra mechanical protection for the push-button guarantees troublefree functioning, even in the most abnormally moist and dusty atmosphere.



Ak 2-L-i (Flush-mounting-type)



Ak 5 sond-i (Surface-mounting type)

The same size of mounting aperture for push-buttons and signal lamps and uniform contact blocks is another welcome feature.

Light operating force, pre-travel and over-travel protect the devices against faulty functioning due to vibration and jerky operations.

Minimum space requirement.

(Continued from page E.26)

BOX

The box is of aluminium. The cover is fastened by a cam latch which can be locked or sealed. It is provided with a gasket which renders the box dust and weatherproof. A ¾" conduit entry is normally provided at the bottom of the box and is fitted with a screwed moulded bush.

The movement is fitted into a stout steel drum to which the switch mechanism is also fitted. The switch and movement assembly is retained in the box by two extended screws and this assembly can be simply removed for servicing.

DIMENSIONS

Height 6"
Width 7⅞" (over hinges.)
Projection 5¾" (over hinges.)

Modern Communication Media in Railway Operation

By Otto Grünberg, Telefunken GMBH, ULm

ABOUT ten years ago the Federal German Railways set the communications industry the task of designing a small portable radiotelephone which was to be suitable for shunting services on railways.

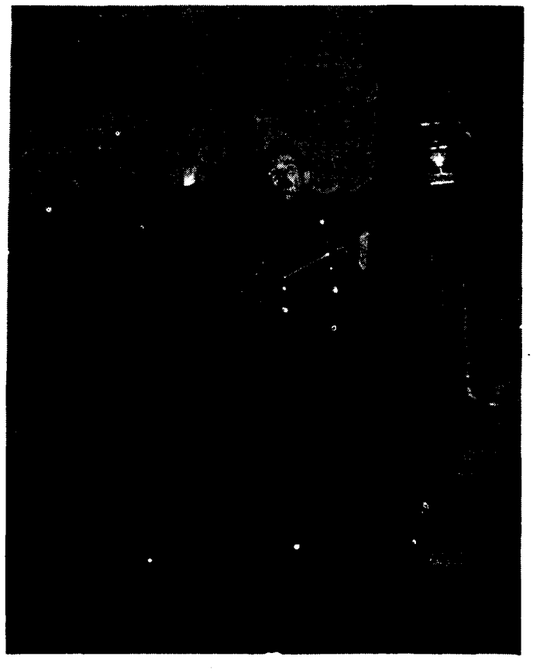
Until now only one company, Telefunken GMBH, has solved the problem in a satisfactory manner. A radiotelephone was developed, known as the " Teleport V ", which—constantly improved during the course of ten years—has acquired an excellent reputation not only in the Federal Republic but all over the world. Hitherto over 10,000 " Teleport " equipments have been supplied which, in various editions, can be tailoured to suit the specific application.

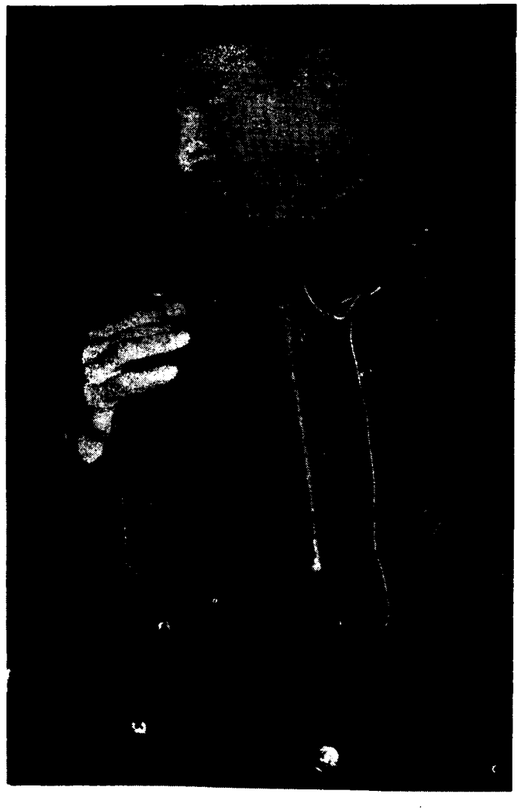
" Teleport " is the portable model as is required for shunting services on the railway.

" Telelok " is a special model for installation in locomotives.

" Telestat " is the fixed opposite station for " Teleport " and " Telelok ".

During the International Fair at New Delhi at the end of 1961 the " Telelok " edition was shown, and afterwards demonstrated to executives of the Indian State Railways. In the opinion of the Indian experts " Telelok " has satisfied, as the only equipment





Switchman at Munich station furnished with " Teleport " radiotelephone.

Telefunken-bild

produced by the international communications industry, all the requirements.

At the present state of the art it is not particularly difficult to meet the electrical data of a specification and consequently there are many types of equipment available on the world market at various prices.

But it is extremely difficult to adapt an equipment constructively to the most difficult conditions of rough railway operation.

And there the special significance of the " Teleport " system may be found.

The Telefunken engineers were successful in developing a system employing uniform basic units, i.e. transmitter and receiver, for all kinds of purposes, whether as portable or fixed station, or fitted in a locomotive.

In this way one of the main anxieties of all large organisations, namely servicing and stocking spares, was reduced to an absolute minimum.

In railway operation the power sources available differ greatly but the " Teleport " set can be adapted to all manner of circumstances.

The portable model is fitted with a small 6 V—10AH lead accumulator whose capacity is adequate for about seven hours operation before it must be recharged. Up to now the lead accumulator has proved to be the most practical and reliable, in spite of other suggested solutions to the problem.

Depending on their type (steam, Diesel or electric) locomotives may have different power sources available for operating a radio-telephone, either a turbine generator, a battery or mains connection.

For the " Telelok " corresponding power supply units were designed which are able to compensate large voltage fluctuations of the primary source of power (6 to 8 V, or 11 to 16 V, or 22 to 32 V).

As a rule fixed stations may be connected to the mains, and in this case a mains-operated power unit with incorporated automatic voltage regulator for 160 to 240 V, 50 or 60 c/s may be utilised.

In railway operation the antennas must also fulfil special requirements.

A switchman, for example, carries the antenna concealed under his clothing. Since a wire antenna cannot be rigged up on a locomotive for reasons of profile, for the " Telelok " a special antenna was designed which in appearance is similar to a can—and as far as is known—the only special antenna of this description in the whole world. The experts of the Indian State Railways were able to satisfy themselves that it really operates satisfactorily.

In fixed stations antennas of all types may be employed.

Portable radiotelephones shall be as light as possible but robust at the same time. For this reason they are housed in cabinets made of sheet steel.

Radiotelephones intended for installation in locomotives must be extremely robust. The weight is not important and cast-metal cabinets can be used but,

The radiotelephone " Teleport ", developed by Telefunken is used for various purposes by the Federal German Railways in the track and siding checking and repair service.

telefunken-foto

because little space is available for mounting in the driver's compartment, they must obviously be as flat as possible.

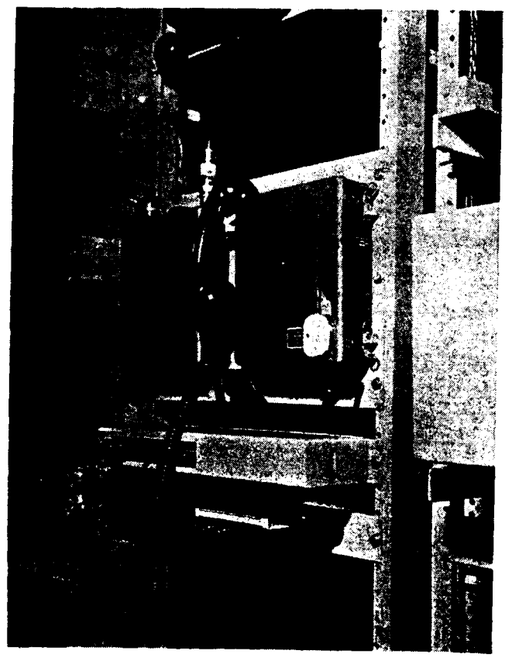
Some remarks must be passed about the noise level too. In shunting operations and in fixed station it is relatively quiet so that a combined dynamic microtelephone having 0.5 W audio output for reception is quite adequate.

But conditions are quite different on a locomotive. The Telefunken engineers went to some trouble to master the noises of a locomotive travelling at full speed. It is not sufficient to increase the loudspeaker output power to 2.5 W with the aid of a transistorised amplifier. A noise-compensated microphone must be used in addition because otherwise the external noises would pass through to the transmitter.

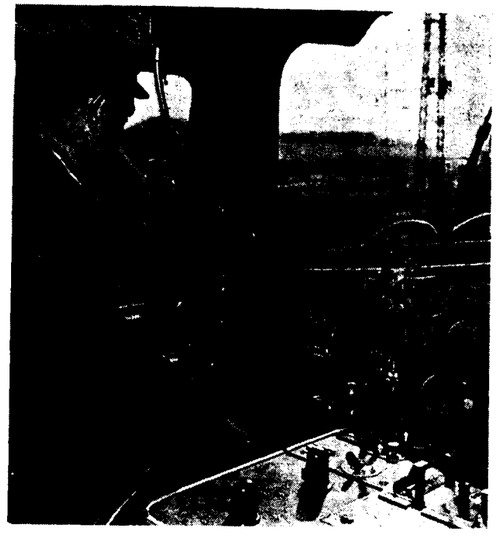
And thus the principal features of the " Teleport " series have been described, namely :

uniform basic units for all editions to reduce servicing and spares stocking to a minimum

special antenna in accordance with the application as portable unit, in a locomotive, or as fixed station cabinet depending on equipment purpose taking the noise level into consideration in locomotives by the use of a transistorised amplifier and a noise-compensated microphone



Radiotelephone " Teleport " installed as stationary equipment (Telestat) in a railway signal cabin.



Radiotelephone " Teleport " produced by Telefunken, fitted as " Telelok " station in a Diesel locomotive of the Federal German Railways.

telefunken-foto

The method of operating the types " Teleport " as portable set, " Telelok " for locomotives and " Telestat " as fixed stations in conjunction in radiotelephone networks will be described briefly in the following remarks.

If the despatch room of a railway station has been equipped with a fixed equipment " Telestat ", then radiotelephone communications may be established over the entire railway station premises for all offices associated with running the railway.

In *shunting operations* communications may be established in a triangle. The switchmen carry " Teleport " equipments and can speak both to the shunting engine driver and the fixed station. Likewise the engine driver can call the switchmen and the fixed station.

In the *wagon checking service* the clerks need not take notes. They simply pass on their messages to the fixed station via their " Teleport " sets.

In *train pushing services* the drivers of both pulling and pushing locomotives communicate with each other by means of " Telelok " equipments.

In addition modern railway stations are equipped with loudspeaker systems (type designation WL) which are connected to the control sets by means of cable. The desk control sets are installed in the station master's office, in the signal cabins, in the foremens' offices, in the workshops and so on. Depending on the necessary organisation the control sets can be furnished for connection with 2, 5, 10 or 20 subscribers. With regard to these equipments also, the constructive design is highly important if they shall prove satisfactory for the special requirements of railway operation.

Originally the radiotelephone networks on railway stations and the loudspeaker systems were operated separately.

Nowadays the " Teleport " radiotelephone system is connected to the WL loudspeaker system which is interconnected by cables.

Hence each fixed radio station may be handled as a telephone connection so that all control sets of a WL system can reach not only the fixed subscribers by cable, but also mobile users via the fixed " Telestat " station.

With the aid of these two systems, described in principle in the foregoing, almost all communications problems encountered in running railway stations and shunting yards can be solved.

In view of the significant increase in the speed of communications economies can be made everywhere.

Encouraged by this success, new tasks were set the communications engineers : the development of a small pocket-size transmitter called the " Solo Transmitter " resulted.

This solo transmitter is intended for one-way communications over short distances.

For example, the supervisor can pass on announcements and instructions via a group of loudspeakers from any point of the platform by radio.

But there are also many other feasible applications.

It is generally known that the compressed air brake system of a newly assembled train must be tested for leaks before departure. For this purpose it is necessary to check each rubber tube connection between the wagons. Since the filling cock is situated at one end of the train, the signal " start pumping " and " stop " must be given every time from each individual test point. This is troublesome and takes time.

For this purpose in modern railways, either a " Teleport " or " Solo Transmitter " is used with which two different call signals may be transmitted. In the cabin where the filling cock is situated, a receiver is installed which picks up these two signals. When the one signal is transmitted then the cock is automatically opened, and when the other signal is transmitted the cock is automatically closed. This procedure is the simplest case of remote control. The radio remote control with the assistance of audio frequencies has been developed further and matured to a system with astonishing fields of application.

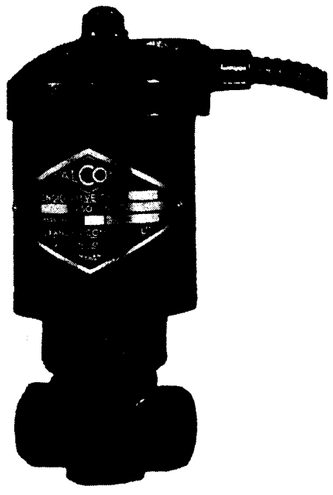
The " Solo Transmitter ", a new miniature transmitter designed by Telefunken for one-way radiotelephone communications and radio remote control. The transmitter, having a power output of 100 mW, is fully transistorised and assembled on chassis with printed circuits in subminiature design.

telefunken-foto

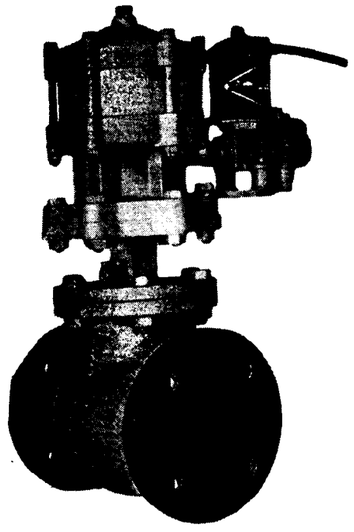
New Types of Control Valves

Messrs. Alexander Controls Ltd., a U.K. firm are manufacturers of new types of solenoid and air operated on-off control valves suitable for industrial applications, valve units manufactured for control of Air, Gases, Water, Steam and Fuel Oil, sizes varying from ¼" – 6" bore. Standard Units fitted with totally enclosed solenoid housings, alternatively weatherproof housings or Buxton certified flameproof solenoid housings.

Some of their equipments are illustrated below :



Standard Solenoid Valve Unit
Size ¼" B.S.P.



Air operated valve unit
size 4" bore

Display range of valve units manufactured
by Alexander Controls Limited

(Continued from page E.31)

It is immaterial whether a crane, a rolling mill, an electricity works or a shunting engine shall be remotely controlled.

Today Telefunken can supply ancillary units for AF remote control which can be operated in conjunction with radio " Telelok-Telestat " systems. The ancillary unit required for the shunting engine is not larger than a medium-sized suitcase. It permits remote control with 20 different commands, including 15 speeds between 2 and 16 k.p.h. alone. Obviously quite a number of safety precautions were embodied to preclude defective operation.

Even the technique of remotely controlling a shunting engine is relatively simple in comparison with a modern automatic rail brake where radar and computer play an important part.

All wagons running down the hump are automatically braked at a predetermined speed because a radar equipment determines the initial speed and a weighing machine ascertains their weight. These two data are passed on to a computer which subsequently transmits a braking command to the rail brake.

The days of improvised signalling in railway operations are gone. By means of radio and cable modern communications equipments not only transmit the spoken word but also permit the remote control of locomotives and braking for shunting services, and many other services on the railways.

Semiconductors... Versatile Products of the Solid State Physics Art

Prepared by International Rectifier Corporation
El Segundo, California, U.S.A.

THE ART

THE art of solid state physics has produced in a very short time such semiconductor devices as rectifiers, diodes, and transistors. Now, on the frontiers of the art, entire circuits are created in solid blocks of semiconductor substances, such as silicon grown crystals, infinitely refined from sand, rock or other materials. They are called semiconductors because they are neither good conductors of electricity, nor good insulators against its flow. They have a multitude of uses, including conversion of energy, voltage regulation, switching, referencing and control. It is predicted that soon solid state semiconductors will enter into all phases of human endeavor.

A MAJOR SUPPLIER

International Rectifier Corporation, a basic science company in the forefront of the " Semiconductor revolution ", is engaged principally in the development, manufacture and sale of rectifiers, diodes, controlled rectifiers, voltage regulators, photoelectric cells and solar cells. The firm is a leading supplier of solar cells for the U. S. space programs, and a subsidiary, Dallons laboratories, is supplying advanced medical instrumentation for U. S. astronauts on " Project Mercury ". Recent development of very high voltage rectifier " columns " has given the company an increasing role in early warning radar systems and thermonuclear fusion research.

WORLD WIDE SCOPE

International Rectifier is engaged in joint ventures for the manufacture of semiconductor devices in Japan, England and Italy, and maintains world-wide sales outlets through which 10 per cent of its sales are made to customers in foreign countries. International Rectifier will begin manufacturing selenium rectifiers in India soon, under a joint venture agreement with Ram Krishan Kulwant Rai, producer of steel and other industrial products, and a substantial import-export firm with headquarters in New Delhi. A new plant will be established in New Delhi, initially for the training of Indian technicians and other personnel. International Rectifier also has associate companies in Holland, Denmark, and France.

GENERAL USES

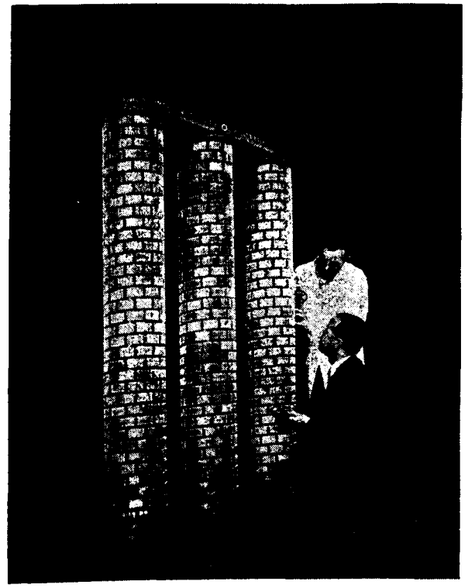
As converters of energy, semiconductors are used mainly to produce electrical energy or electrical power from other energy sources, such as thermal converters, radiant energy converters like sun batteries and nuclear energy converters, the three categories into which all nuclear and astronomic energy evidently falls. A wide field of application for semiconductor devices is conversion of electric power from alternating to direct current. Since semiconductors entered the picture, the use of direct current is increasing because they permit inexpensive conversion. Specific fields of semiconductor application are electrochemistry

IR SOLAR CELLS POWER TIROS II

In a magnetic field similar to that which surrounds the earth in space, photo floods of intensive brilliance were used to test the 9,260 solar cells supplied to RCA Astro-Electronics Division by International Rectifier Corporation for TIROS II, the second weather-eye satellite successfully orbited.

Photo Courtesy of RCA

(covering reduction of such metals as aluminum and magnesium) and other processing industries, such as manufacture of graphite. Semiconductors also hold promise of a revolution in general industrial drives in steel and other heavy industries, and in electrification of railroads. They also have many applications in direct power for new processes, such as vacuum furnaces and electron beam furnaces, and wherever high power, high frequency generators are desirable. The revolution through solid state physics, in fact, has been equated by some scientists with the industrial revolution of 150 years ago. But the most exciting " man in the street " prospects lie in the following applications.

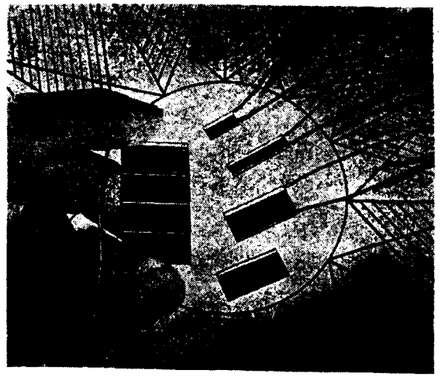


35,000 Volt/55 Ampere Super Power High Surge Current Rectifier Columns Convert More Power Than Any Rectifier of Comparable Size Ever Built!

The assembly pictured is one of two three-phase bridge rectifiers supplied by International Rectifier for a radar beam power supply. Each bridge is rated at 35,000 volts d.c. @ 55 amperes continuous. Connected in parallel, the two bridges will produce 35,000 volts @ 110 amperes ... in series: 70,000 volts @ 55 amperes. They will withstand a 1000-ampere d.c. short circuit current for 10 cycles (1/6 sec.). Each of the three columns in the above assembly consists of 360 modules, each containing one IR 45 series rectifier cell.

THERMO-ELECTRON REFRIGERATION

Thermoelectronic refrigeration is here now, in small units of a cubic foot in size. A Chicago hotel now under construction will have such units for convenience of guests in every room. Larger home refrigerators are two to five years away, but possible and feasible. Essentially, however, large central refrigerators are not really necessary; they are the outgrowth of the economics of compression. Large central compressors are more economical than several small ones. Units for either cooling or heating (the same device does both simply by reversing the flow of current) are really needed in different parts of the house, like warming or cooling a baby's bottle in the nursery, or making ice in the den or recreation room. It's also possible to generate electricity on the same principle with low cost fuels, even wood fire, for uses like operating radios, camping lights or other devices that don't require much electrical energy.



Rugged New High Efficiency Silicon Solar Cells (Module, left, and unmounted styles)

Watchmaking—Watches utilizing semiconductor devices like transistors and diodes are already here. Watches with " works " made entirely of solid state " blocks " should be here within a year. These will rely on no individual components, have no moving parts except the hands and whatever mechanism is needed to operate them. They will keep almost perfect time, and when minute adjustments are necessary, they will probably be made from central transmitters beaming out unheard signals. Semiconductors and solids state circuitry will make ever smaller and beautifully designed watches possible.

They will also be far more rugged and require almost no maintenance.

Automobiles—Semiconductors in auto ignition systems are already here. One U. S. manufacture is using them in inductor alternators that replace conventional brush and armature generators. The advantage is that they keep the battery always fully charged even at idling speed and reduce battery trouble. Entire ignition systems using semiconductors are being used experimentally in Europe and may soon reach the United States. Spark plugs may soon be a thing of the past, with whole ignition systems produced out of a single " block " of a substance like silicon. Advantages will be trouble-free operation, greater shock resistance, fewer parts to wear out, more electricity available for more operational uses. Low cost thermo-electric generators are also immediately possible through important breakthroughs in such power devices.

Photography—Solid state means of recording and reproducing images is already feasible, through no devices are actually known to exist that utilize the phenomenon. A somewhat similar process is already being used in television for storage and transmission of images. Considerable research and development work is under way on devices that will retain photos in solid state substances indefinitely, or erase them after prints are made, just as magnetic tapes today are used to store and reproduce sound. In photography, solid state physics will undoubtedly lead to partial or even complete replacement of strip film and chemicals now used in film processing It will bring about instantaneous printing of photos, greatly accelerating picture coverage of events, and making possible photo judgment on the spot, thus saving much needless " second take " exposure. Solid state processes may also make obsolete, for better or for worse, that colorful cry of the press photographer, " Just one more please."

Ultrasonics—Even greater developments can be expected in this increasingly important field through miniaturization of equipment offering the physician greater portability. A doctor treating a bedridden arthritic patient or a victim of bursitis will be able to carry an ultrasonic kit with him wherever he goes. Quicker and more accurate diagnosis will be possible with ultrasonic photography of soft tissues which the University of Colorado has successfully pioneered. Also, treatment of internal postoperative scars or external scar tissue left by injuries or severe incisions, which the University of California at Berkeley has been successfully treating and removing with ultrasonics. This, incidentally, is the branch of physical science which employs frequencies beyond the range of sound, 20 thousand cycles and over, which heal by stimulating human cells to renewed activity or in the case of growths like calcium, literally bombarding them away with sound.

BRASS TUBES FOR GENERAL PURPOSES

The Indian Standards Institution has published IS: 407-1961 Specification for Brass Tubes for General Purposes (Revised). This standard covers the requirements of solid drawn brass tubes for the manufacture of hand tyre inflators and other general purposes, and specifies the preferred method of designating tubes by their outside diameter and lays down the permitted tolerances on outside diameter, thickness and lengh of tubes.

The standard which was first issued in 1953 has now been revised. The main modifications made in this revision relate to inculsion of sizes and tolerances in accordance with the latest draft ISO document on dimensions of round copper tubes. Pressure tests have also been modified in accordance with B.S. Schedule on copper and copper alloys tubes published by the British Standards Institution.

* * *

HIGH SILICA SAND FOR USE IN FOUNDRIES

The Indian Standards Institution has published IS: 1987-1962 Specification for High Silica Sand for Use in Foundries, which covers the requirements for high silica sand for use at high temperatures in foundries.

This standard has been prepared with a view to meeting the requirements for foundries for high silica sand, keeping in view the quality of sand available and known to be commercially exploited at present in the country.

Metric system has been adopted in India and all quantities in this standard have been given in this system.

STEEL SUPPLEMENT

Electrical Precipitation in the Iron and Steel Industry

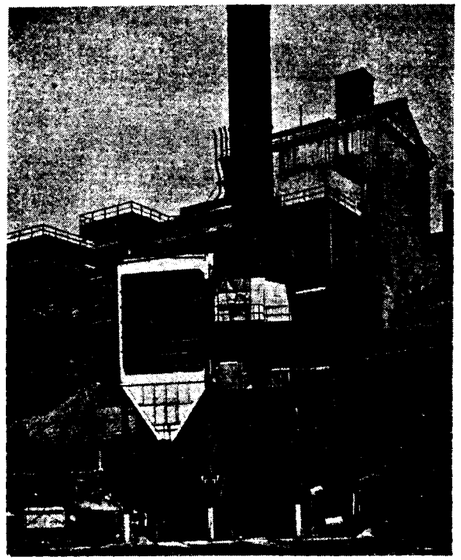
By J. Spencer Smith

AT the turn of the century intensive and fundamental research work on electrical precipitation was begun by Sir Oliver Lodge. Now, more than fifty years after, the company that still bears his name, Lodge-Cottrell, Limited, is one of the world's leading organisations specializing in this high efficiency process of gas cleaning and dust collection.

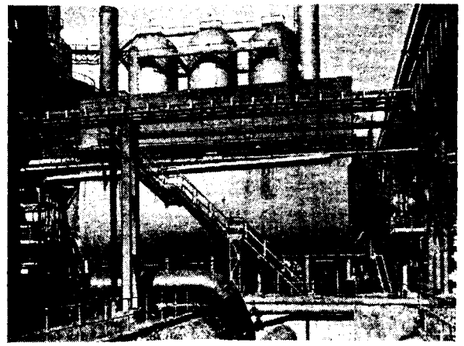
The principle of electro precipitation, briefly, is that of passing dust-entrained gases through an intense electrical field set up by electrodes of negative and positive polarity alternately spaced. The dust particles receive a negative charge which propels them to the positive collecting electrodes, where the particles agglomerate until periodically removed. Because of the vast quantities of gas to be cleaned and the high efficiencies demanded, precipitators are sizeable pieces of equipment and their initial cost is by no means trivial. The precipitator, while having a comparatively high initial cost comes into its own when running costs are taken into account. It presents negligible resistance to the gas flow and thus hardly affects Fan-power ; it does not suffer from the effects of abrasion, and it requires little attention other than routine inspection and maintenance.

Particularly in the Iron and Steel Industry, lodge-Cottrell, Limited, have always been in the forefront ; as long ago as 1915 their first Blast Furnace Gas Cleaning Plant was being installed. Since then they have been responsible for several hundreds of precipitator units in various industries. Their impressive total number of blast furnace gas cleaning installations is now well over the hundred mark and includes eight units at Tatanagar for the Tata Iron and Steel Company, Limited, and five units at Burnpur for the Indian Iron and Steel Company Limited.

In recent years the rapid expansion in the Iron and Steel Industry, the development of new processes,



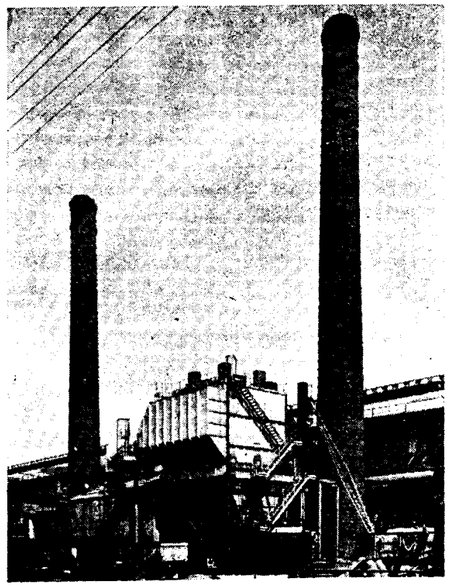
An Electrical Precipitator on an LD/AC oxygen converter unit, incorporating waste-heat boiler and cooling tower.



A Blast-Furnace Gas-Cleaning Installation, showing the electrical precipitator and scrubber towers.

and a more stringent enforcement of clean air regulations have meant a considerable expenditure on gas cleaning and dust collection plant. To meet these exacting conditions and the high efficiencies required, the trend has been towards a much greater use of electro precipitation, hitherto mainly confined to blast furnace gas cleaning in the industry.

Precipitators are now operating quite successfully on Sinter Plant, Open Hearth Furnaces, Converters, and De-Seamers. Efficiencies of 99% or more are the order of the day ; anything less, while possibly removing most of the dust, would still give a visible plume from the chimney stacks and would have an adverse psychological effect.



Oxygen-process open-hearth ("Ajax") furnace fume precipitator, with waste-heat boiler.

On oxygen steelmaking units the dense iron oxide fumes are emitted at a vey high temperature, and before the fumes can be cleaned by electrical precipitation the gases must be cooled either by the use of waste heat boilers or water spray cooling towers.

The problem of disposing of the precipitated dust from steelmaking units has received much attention in recent years and as the dust is mostly iron oxide, representing a considerable tonnage of raw material, a successful solution to the disposal problem would contribute to the cost of operation. Machines for pelletising and granulating the dust have shown a great deal of promise and have enabled the iron oxide pellets to be fed back either on to the sinter strand or directly into the steel furnaces. In a competitive world money cannot always be spared for what have so far been non-productive pieces of equipment such as electrical precipitators and while clean air is desirable and perhaps necessary, the gap between what is socially ideal and what is economically practical can only be bridged over a period of time. The vast experience and knowledge acquired by Lodge-Cottrell Limited, in nearly fifty years of practical engineering in the field of electro precipitation is playing an ever increasing part in helping industry to overcome problems of atmospheric pollution.

Lodge-Cottrell, Limited, are now members of the Simon Engineering Group, and their business interests in India are looked after by Simon-Carves, Limited, Calcutta.

LEAD PLATING

The Indian Standards Institution has published IS: 1992–1962 Specification for Lead Plating, which covers the tests and requirements for electro-deposited lead coatings on steel, copper and copper base alloys, intended to withstand corrosion.

The use of electroplated lead coating is increasing for protection of articles made of steel, copper and copper base alloys against certain acids, corrosive liquids and atmospheres and as a substitute for the more expensive and less easily available metals.

Metric system has been adopted in India and all quantities and dimensions in this standard have been given in this system. However, for ready reference and for the sake of smooth changeover to metric system by electroplating industry, non-metric equivalents of these values have been indicated, wherever necessary.

The standard published in English is priced at Rs. 2.50 and its copies are available from the office of the Indian Standards Institution. Manak Bhavan, 9, Mathura Road, New Delhi—1 and from its Branch Offices located at Bombay, Calcutta, Kanpur and Madras.

Steelmaking in an oxygen-blown steelworks

Refining by a new process - further developments expected

By Dipl.-Ing. F. Toussaint
DEMAG AG, Duisburg/Germany

THERE are two metallurgical problems to be solved in making medium carbon steel. The first is the melting (scrap) and heat up (raising the temperature of the bath from about 1200°C to approximately 1600°C); the second is the "refining", i. e. oxidation, the burning off of accompanying elements such as carbon, silicon, phosphorus and sulphur.

The heat required for melting and heating up the open-hearth furnace is provided by gas or oil firing, Refining, of subordintate importance in the O. H. furnace owing to the hot metal charge often being smaller, is effected by means of oxygen fed to the furnace in the combustion air. In the basic Bessemer converter refining is carried out by air being blown in at the bottom under pressure. A certain quantity of heat is generated during this process, but is largely carried off in the waste gases, since the air also contains a large volume of cold, inactive nitrogen. The result is that the heat generated is sufficient to permit the necessary temperature to be obtained, but only small quantities of scarp can be melted. These two classical processes for steelmaking (the electric steel process can, for the purpose of this discussion, be equated with the O. H. process) are thus used for two different purposes, the use to which they are put being determined by the very nature of the processes. The O. H. furnace is used for melting scrap, and the basic Bessemer converter for refining hot metal. This consideration is not affected by the fact that today the O. H. furnace is often operated with a higher proportion of hot metal charge for various reasons. This latter is partly due to fact that there was no suitable process which offered both the advantage of high percentage hot metal charge on the one hand and the O. H. furnace advantage of low nitrogen content on the other. The advantage of operating with a high percentage of hot metal in the charge is determined by the market situation at any particular time and also by the considerably lower content of trace elements such as copper, tin and chromium. There were two groups of problems involved in developing the basic Bessemer process so as to include all these advantages :

(1) The heat econmy of the converter must be improved, so as to obtain best possible utilization of the heat generated during the oxidation process.

(2) Improvements of a metallurgical nature must be obtained, i. e. the nitrogen content of the steel must be lowered, and de-phosphorization improved.

A whole series of improvements was introduced and resulted in certain successful results being obtained. These included enrichment of the blowing air with oxygen or adding steam of carbon dioxide to the blast.

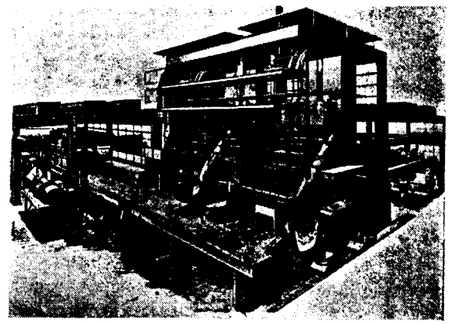
THE LD PROCESS

The most important idea, however, that of blowing on to the bath with pure oxygen instead of air (experiments showed that the converter bottom could not withstand the employment of bottom blowing with pure oxygen) was born as early as last century! It is very interesting that Bessemer proposed this method of blowing. It was not possible to put the idea into practice, however, owing the high cost of pure oxygen. It was not until the Linde-Franckle Process allowed large quantities of pure oxygen to be produced at a reasonable price that it was possible to take up the idea again and carry out practical trials on a large scale. Lellep, Durrer and Schwarz are just a few of the names that may be mentioned as having played a prominent part in developing the metallurgy of the process. Blowing pure oxygen onto the surface of the bath at the same time solved all the difficulties mentioned. The heat economy of the process was considerably improved, and large quantities of scarp could be melted in the charge. At the same time, extremely low nitrogen contents can be obtained, indeed, sometimes they are lower than those for O. H. steels, since the bath no longer comes into contact with air. The problem of removal of the greater proportion of phosphorus in the basic Bessemer process was due to the fact that a mobile slag—necessary for thorough dephosphorization—is only produced towards the end of the process. However, when top blowing is carried out with oxygen, the lime is already melted at the beginning owing to the high local temperatures where the oxygen impinges on the bath. In addition, this process also has the advantage of being flexible enough to take advantage of conditions on the raw materials market by using ore instead of scrap. The heat energy required for melting 3 tons of scrap is equivalent to that required to dissolve, reduce the iron oxide and slag the gangue from 1 ton of ore. This wide variety of advantages as compared with the conventional processes ensured the rapid spread of the "LD Process", which was named after the Austrian towns of Linz and Donawitz where the Vereinigte Osterreichische Eisen—und Stahlwerke (VOEST) and the Alpine Montangesellschaft are located. There have since been a large number of metallurgists and design engineers who have taken up developing the process further, so that today there is already a large number of special processes which are based on the use of pure oxygen for refining hot metal. Although it is difficult for the uninitiated to get a clear picture of the situation, it is not very difficult to arrange them methodically.

The pure LD Process employs a refining vessel which is either a converter or crucible having a closed bottom and, in contrast to the basic Bessemer converter, is for this reason symmetrical about its axis of rotation. Nowadays it usually also has a taphole in the upper section which enables slag and steel to be properly separated; the steel is tapped of first through the smaller taphole, and the slag is then discharged through the mouth of the vessel. The LD Process can be employed for processing hot metal containing up to 0.5% phosphorus, it being possible to use up to about 25% scrap in the charge.

THE ROTOR PROCESS

Efforts to obtain a more intensive and rapid reaction between the bath and the slag led to the introduction of the rotating vessel, an oxygen lance being introduced at one end and the vessel rotating about its longitudinal axis. The Oberhausen "Graef Rotor" has two lances, one of which dips into the bath while the other introduces a weak current of oxygen into the vessel. This latter oxygen reacts with the CO formed during decarbonisation and oxidises it completely to CO_2. The "Kaldo Rotor" makes uses a rather different method. This process takes its name from Bo Kalling and the Domnarvet Works of the Fergesta company in Sweden where it was developed. It provides for higher speeds of rotation (up to 30 rpm) and therefore accelerates the refining process. Only one lance is used which blows onto the top of the bath and



Drawing showing the section of a LDAC Steelplant with two converters.

The first converter (righthand) shows how pure oxygen is just blown on the bath.

The other one just is charged with pig iron.

This most modern type of steelplant DEMAG is just building for one of the most famous integrated Iron and Steel Plants in Europe.

LD converters will be used in the extention of the Mysore Iron and Steel Plant by DEMAG.

both speeds up refining and ensures complete combustion. Both processes enable high phosphorus hot metal to be refined, especially when a second slag is employed, i. e. the first slag produced during preliminary dephosphorization is tapped off and replaced by a new slag (a smaller quantity) whose FeO content has been brought to a high level. This ensures excellent dephosphorization. This slag remains in the vessel, since it contains a large proportion of iron on the one hand and on the other the phosphorus content is so low that it can be used as first slag again.

The Rotor developed by Hardt at Klockner in Haspe and which first became known only a few weeks ago goes a step further for increasing the speed of refining. The vessel is of elliptical section and therefore ensures extremely intensive mixing of slag

and bath, the result being astonishingly short refining times which can normally only be obtained in the basic Bessemer converter, viz. 10 to 15 minutes per melt.

OXYGEN BLOWING PROCESSES USING LIME

The pure LD Process permits the processing of hot metal having a phosphorus content of up to about 0.5%. Various companies have been working on the further development of the LD converter and attempting to employ this relatively simple vessel for refining basic Bessemer hot metal, too. Metz in Dudelingen developed the LD-AC Process. At the same time as oxygen is blown onto the surface of the bath, powdered lime is blown onto it, too, so as form a reactive slag quickly. This slag ensures rapid dephosphorization. The French OLP (oxygen lance powder) Process is rather similar. It differs, however, from the LD-AC Process mainly in the operating conditions and the method employed to feed in the lime. Both processes usually employ a second slag so as to make low phosphorus steels economically. Another process uses lime in lumps instead of the powdered material and gives similar results.

THE PL PROCESS

Phoenix-Rheinrohr in Rheinort developed the special process, the Phoenix-Lance Process, which utilizes the classical basic Bessemer converter and is therefore rather a special case. The steel produced is of as good a quality as that made by the other processes. The method used employs a clever artifice to obtain both low nitrogen and low phosphorus contents. It is a known fact that during the decarbonisation period, i. e. while CO is being formed in the bath, nitrogen is not only not absorbed when bottom blowing is employed, but it is in fact given off (flushing effect). For this reason during the PL Process bottom blowing is stopped while there is still sufficient carbon present (about 0.2 to 0.3%). The converter is then swung into the horizontal positon, and an oxygen lance which is curved at its end so as to blow direct onto the surface of the bath is introduced. A slag rich in FeO is produced very rapidly. After this phase the converter is tilted into the vertical position again and bottom blowing carried out again. Nitrogen is not absorbed, the remaining carbon is removed, and the highly reactive slag dephosphorizes the bath effectively and rapidly. In this process, too, very short refining times are of course obtained. The main advantage of this process is that existing basic Bessemer converters can be employed for making high-grade steels.

It cannot, at the present time, be judged which of this wealth of processes will come into more widespread use, especially since there is no adequate basis for comparison. In the long run the economics will, in addition to the metallurgical results obtained, be of decisive importance. The economics are determined by investment and operating costs. There are, for example, still a number of questions to be answered. One of them, which is particularly important for the Rotor processes is the service life of the vessel lining. In any case it is quite certain that the refining of hot metal with pure oxygen is already a technically reliable process which can look forward to outstanding developments in the future. The High Authority of the European Coal and Steel Community estimates that (VDI-Nachrichten No. 8/1961) the production of oxygen-blown steel, which was only 1.2 million tons in 1959 for the entire Coal and Steel Community, will increase to 17 million tons within three years, the production of basic Bessemer steel being reduced at the same time by 4.3 to 30 million tons through the closing down of obsolete plants.

Mechanization in Large Coal Preparation

By Dipl.-Ing. F. Brinkmann, Dortmund

COAL Preparation Plants handling minus 150 mm coal may be called automatic systems, as there is a continuous flow of the raw coal and products from the primary screen feeder over the various preparation facilities, such as heavy media separators, flotation cells, filters and classifying screens, to the bins for the final products. Generally, plant operators need not interfere in this process:

Contrary to what is practised in those plants by far the greater part of the screening installations are still using hand-picking on picking belts (Fig. 1) with high personnel requirements. As this kind of work in a dusty atmosphere is most troublesome and monotonous, nobody likes to do it. Thus it becomes more and more difficult to find necessary aids for this job. This shortness must be compensated by the technique which is to facilitate labour conditions and help saving labour wherever possible.

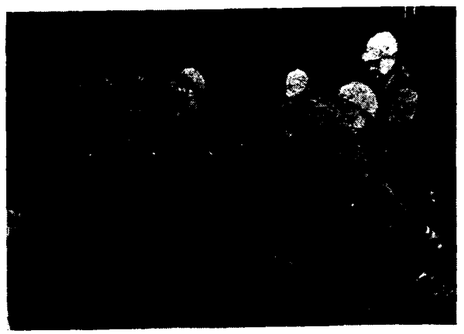


Fig. 1. Picking Belt.

There are two possibilities of mechanizing a screening plant, namely,

1. The whole of the large coal is crushed down to wash coal size, i.e., minus 150 mm :
   (a) together with the refuse,
   (b) after preliminary separation of the refuse.
2. The large coal is washed separately in a heavy medium with a view to being sold as marketable large coal.

It is not recommendable to crush the whole of the large coal together with the refuse because of the degradation of coal incurred even when using a Bradford breaker or vibrating screen breaker (1).

Fig. 2 shows the increase of the proportion of smalls in the crushed product in relationship to the percentage of refuse in the crusher feed. These tests were carried out by three mining companies.

(a) on anthracite in Northern Westphalia (4),

(b) on bituminous coal in the Ruhr District (3),

(c) on anthracite in Lower Rhineland.

Before evaluation of the smalls from the crushed product these were separated by float-and-sink tests.

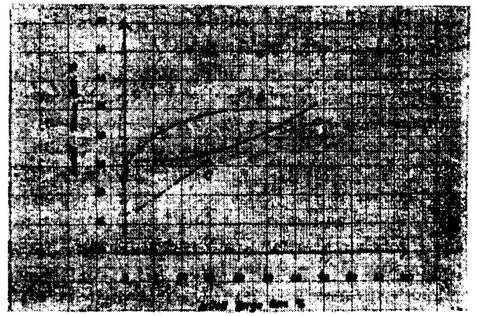


Fig. 2. Proportion of smalls in the crushed product in relationship to the amount of refuse in the crusher feed.

(1) Figures in brackets relate to the references at the end of the paper.

Those three independent tests show the percentage of smalls to be by more than 10 per cent higher when crushing large coal and refuse together. This means that the economical success of a plant will diminish due to the following reasons :

— The cleaning expenses increase.

— The cleaning efficiency decreases.

— The smalls of certain commercial grades of coal may have to be sold at a lower price.

The smaller the coal the higher the cleaning expenses. Mention should be made of the expensive treatment of slurry or the high loss of medium solids when washing small coal in a heavy medium. The following is a comparison of the cleaning expenses including capital-cost (2, 1):

Coarse coal	100 per cent
Smalls	157 per cent
Coal fines	250 per cent

The cleaning efficiency decreases with the size of raw coal to be treated. Figures that may be expected in modern washeries treating

120—10 mm coal: $E/_T = 0{,}03$

10—0,5 mm coal: $E/_T = 0{,}08$

A decrease in cleaning efficiencies means higher losses.

With the exception of coking coal the coarser grades can be marketed at a higher price or even double the price of the smalls, when selling anthracite. It is also more difficult to adapt the smalls to actual market requirements, for it is always cheaper to crush large coal, if necessary, than to briquette small coal.

As the coarse size raw coals contain larger and widely varying amounts of refuse, preliminary separation of refuse relieves the subsequent cleaning process and provides for a uniform feed. Cleaning results of the Baum jigs have been improved. Refuse is preferably eliminated not only from the large coal but also from part of the coarse coal. e.g., from the plus 80 mm fraction to compensate for the increased proportion of refuse which is due to mechanization underground. Preliminary refuse separation systems have been installed in a great number of existing screening plants (Fig. 3). Wear and tear in the washery is being reduced. On the other hand, when crushing the coal lumps together with the refuse, existing washeries would be additionally loaded, with the proportion of material having so far been hand-picked.

The flow scheme shown in Fig. 4 is an example of how a screening plant could be largely mechanized nowadays. As shown therein, raw coal is separated into 150—0 mm, 700—150 mm and plus 700 mm in a revolving screen. The minus 150 mm fraction goes to the washery. Timber and tramp iron are discarded by hand from the 700—150 mm coal prior to the refuse being eliminated by a Teska washer. The floats consisting of clean coal plus middlings may be crushed down and mixed to the 150—0 mm fraction or may be separated into clean coal and middlings in a second

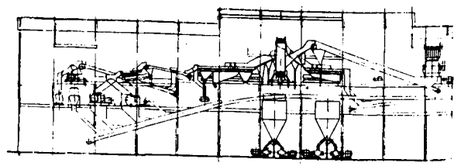


Fig. 3. Preliminary separation of refuse in an old screening plant

Teska to meet large coal market requirements. The plus 700 mm lumps are kept separately in order to avoid clogging of the chutes and machines. From the relatively few lumps obtained per day foreign material and refuse are discarded on a picking belt by means of a shifting device provided at this end.

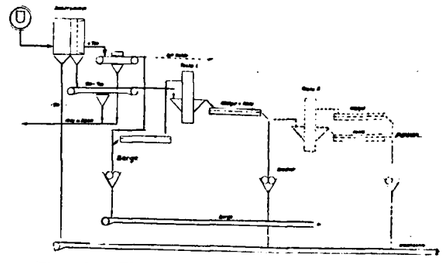


Fig. 4. Flow scheme of a mechanical preliminary refuse separation and large coal preparation plant

A revolving screen has been selected for screening at 700 mm, as any lumps obstructing the perforated plates are thorwn off the perforations from the top of the rotating drum. The last section of the drum could be designed as a breaking drum to break the few plus 700 mm lumps to minus 700 mm size.

Mechanical preparation of large coal in a heavy medium requires a heavy medium separator with sinks discharge being capable of handling the big lumps of

refuse, of which the Teska Separator* is an example (Fig. 5), It mainly consists of a bucket drum (a) slowly rotating on support rollers arranged outside the bath and static end weirs (b, c) which close the drum half-way. The unconfined overflow weirs for the floats as well as the bucket drum of unlimited capacity permitting the sinks to be freely dropped (d) ensure high rates of throughput and trouble-free operation.

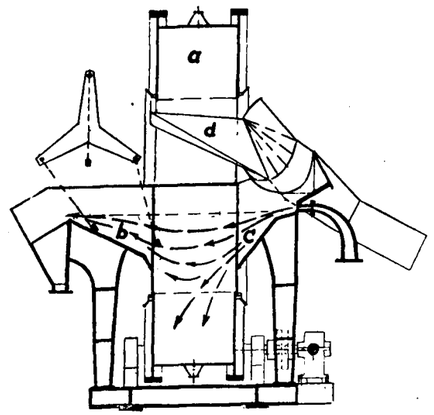


Fig. 5. TESKA with upward and downward medium currents

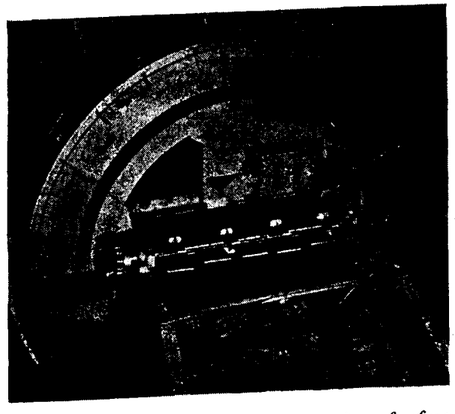


Fig. 6. TESKA for preliminary separation of refuse

The Teska has been so designed that unavoidable wear is restricted to a few points which can be easily controlled and are accessible from outside.

* The Teska is built by SKB/Germany, Link-Belt/USA, Mitsubishi/Japan, W. J. Jenkins/England.

As the main object of preliminary separation of refuse in a heavy medium is to discharge absolutely pure refuse without any adherent coal, a specific gravity of separation of 2, 1—2, 2 is required, which is obtained by use of coarse-grained medium solids without the admissible medium viscosity being exceeded. The loss of heavy mineral with the Teska process is not more than 50 grammes per ton of feed. This low loss is the reason for wear and tear being at a minimum, as the residence time of the heavy mineral in the circuit is a long one, when the solids particles will loose their angular shape and abrasive properties (5).

SUMMARY

The mechanization of screening plants becomes a necessity. Crushing of the whole of the large coal is not feasible, because the percentage of smalls would increase by more than 10 per cent. More raw smalls mean higher cleaning expenses, reduced cleaning efficiency, lower proceeds, and consequently losses to the mining companies.

By use of a preliminary refuse separation system the coal is gently handled. Moreover, the subsequent washing process is relieved and wear is reduced.

Only a heavy medium separator having an unconfined medium bath and allowing the lumpy sinks to be freely dropped can be used to this effect. It is also recommendable to use coarse medium solids to prevent the medium from getting too viscous in view of the high specific gravity of separation of 2.1—2.2 required.

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In der Wasche der Zeche Shamrock 3/4 sind

New Finnish Smelting Process Employs British Toroidal Combustion System

A radically new flash-smelting process will shortly be brought on stream by Outokumpu Oy in a new installation being built at Kokkola, central Finland.

When Outokumpu originated commercial scale flash-smelting for nickel and copper sulphide concentrates the process attracted world wide attention and was adopted by the Japanese for their smelter at Ashio which went into production in 1956. In this process oxidation reactions between pre-heated air and dried concentrate take place in a vertical reaction shaft in a downwardly flowing co-current system.

The system which Outokumpu have now invented requires the virtual elimination of oxygen from the reaction zone but at the same time no detectable quantity of free carbon is permissable in the gases entering the reaction shaft from the combustion chambers.

The simultaneous attainment of these two objectives when burning a cheap grade of fuel oil presents a most difficult combustion problem, but, the commercial success of the Kokkola project relied absolutely on finding a combustion system capable of burning Bunker C oil to completion with no more than the stoichiometric quantity of air.

The Finnish company approached eight different manufacturers of oil burning equipment in the U.S.A.., Germany and the United Kingdom in their search for the vital system. It was not, however, until they approached Urquhart's (1926) Ltd., of Perivale, Middlesex, that their requirements were realised; Urquharts had recently invented their toroidal combustion system for burning heavy residual oils to theoretical completion, exactly matching the requirements of the Finnish plant.

A pilot plant to demonstrate stoichiometric burning of heavy oil in a toroidal combustion chamber was set up at Perivale, where smoke readings at the outlet of the chamber were repeatedly shown to be very close to zero. The decision to manufacture the full-scale plant was taken by the Finnish.company and Urquhart's were given orders to design and manufacture equipment for burning up to 8½ tons of oil an hour, guaranteed to produce virtually zero free carbon with zero excess oxygen in the combustion products.

Urquharts are providing six toroidal chambers for this duty. These will be arranged to fire, approximately radially, into the vertical reaction shaft. Each chamber will be capable of burning up to 1½ tons of oil an hour, sufficient, collectively, for the flash-smelting of 1,000 tons of ore a day.

The residual heat in the process gases leaving the furnace will be extracted in large waste-heat boilers and used for generating electricity for the Finnish Grid.

(Continued from page S.8)

an dem von der Schuchtermann & Kremer-Baum A. G. gelieferten Zweiwalzenbrecher Untersuchungen uber den Kornaufbau des Austrags unter folgenden abzuwandelnden Bedingungen durchzufuhren :

1. Unterschiedliche Belastung
2. Verschiedene Korngroben der Brecheraufgabe
3. Unterschiedliche Bergeanteile
4. Verschiedene Federspannung

In Abhangigkeit von den Bedingungen 1—4 ist jeweils durch Sink- und Schwimmanalyse die stoffliche Zusammensetzung der einzelnen Siebklassen zu prufen.

Aufbereitungstechnische Meldearbeit, angefertigt im Marz 1958.

4. Puffe, Edgar :

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5. Brinkmann, Franz :

   Die Verwendung von grobem Schwerstoff in Schwertrube-waschen und seine Ruckgewinnung mit Hilfe der Schwer-kraft. Gluckauf 96 (1960) S. 1275/81.

STOICHIOMETRIC COMBUSTION OF HEAVY OIL

The six toroidal combustion chambers which from the indispensable heart of the flash smelting process will be making combustion history in burning heavy residual oil smokelessly under stoichiometric conditions. *This has never been done before and it opens the way to many new thermal processes for which a smoke-free neutral or reducing atmosphere is needed.*

The difficulty in doing this is that normally, when no excess oxygen is present there is a dramatic slowing down of any combustion reaction in its later stages; completion is only attained after a long time, if at all, and results in long smoky flames. This happens because most of the molecular components of the combustion reaction have paired off, leaving large spaces separating the few remaining fuel and oxygen molecules, which thermal agitation alone is not sufficient to bring together.

In the Urquhart toroidal combustion system every contributing mechanism in the combustion process is enhanced by the application of careful scientific design, the co-operative effect of which is cumulative and strikingly greater than any single contribution would have promised.

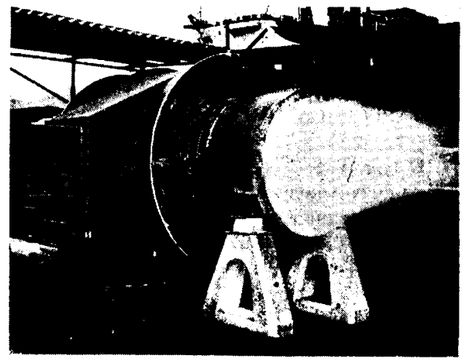
The contributors to success are extremely fine atomisation, exceptionally vigorous and continual mixing, powerful radiation from the chamber wall and very high flame temperature obtained by drastic pre-heating of the combustion air. The resulting combustion gases have the transparent yellow/orange colour characteristic of a sodium flame, but exhibit no white (carbon) luminosity at all. Their temperature is close to theoretical as nearly all the radiated heat transferred to the walls of the chamber is returned to the flame by the pre-heated air. This procedure also safeguards the refractory walls and enables their measured temperature to be held at 1,300°C. Only the walls near the outlet of the chamber significantly exceed this temperature, and in this zone it is necessary to use very high grade refractory material.

THE FLASH SMELTING FURNACE

There are several specific problems associated with the flash-smelting furnace which react on the combustion equipment. Among them is the desirability of avoiding direct cross radiation between opposing combustion chambers and the necessity to prevent the ingress of ore dust. These requirements are provided for by the disposition of the chambers in relation to the reaction shaft, the tangentiality and downward skewness of the incoming gas streams from them being decided relative to the migratory characteristics of the ore particles in the rotating column of gas. While a rotary motion ensures the longest dwell time for all particles in the high temperature zone, heavy particles tend to be centrifuged out. It is important that overmuch radial movement towards the walls and chamber mouth be prevented.

It is necessary to provide quick and simple replacement of the burner for maintenance purposes, an operation requiring special consideration because the reaction shaft operates at a positive pressure of 10 in. w. g. Removal of the atomiser without special precautions would be accompanied by a blast of incandescent gas and ore particles travelling at several hundred feet a second. To make it possible to withdraw the atomiser, a combined air-lock and shut-off damper has been provided behind the point where the atomiser enters the chamber. These components interlock with the control system to eliminate the danger of hot gas escaping from the pressurised combustion space.

Finally, it was necessary to provide for gentle heating up of the chrome magnesite lining of the furnace shaft. Advantage was taken here of the large turn down available with the toroidal chambers to give an extremely slow and careful increase of heat from a very low initial oil rate.



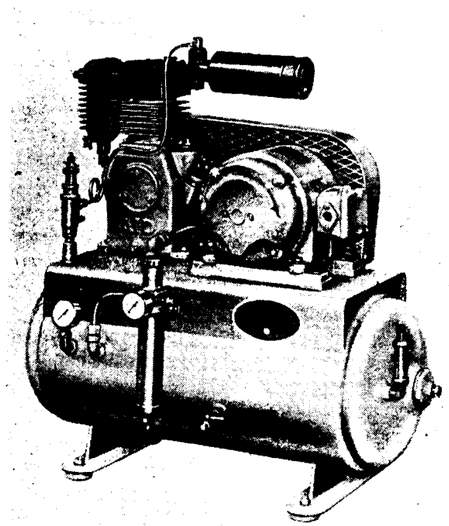
Urquharts Toroidal Combustion System for Finnish Smelting Process

The illustration shows one of the six toroidal chambers designed and manufactured by Urquhart's (1926) Ltd., for a new Flash Smelting Process for the Outokumpu Oy at Kokkola, Finland, on test at Urquhart's Bristol plant in the Albion Dockyard. Each chamber will be capable of burning up to 1½ tons of oil an hour to theoretical completion, producing virtually zero free carbon with zero excess oxygen in the combustion products.

New Types of Compressors from U.K.

E. S. 7 SPECIFICATION

THE type E. S. 7. is available as a Semi-Automatic or Fully-Automatic unit and for use from 3 phase or single phase supplies. This compressor is a single cylinder vertical air cooled unit with a $2\frac{3}{4}$" bore × $2\frac{1}{8}$" stroke, when running at 1,000 r. p. m. it has a displacement of 7 cu. ft. min.



ES 7 Stationary Model. Semi or Fully Automatic

The compressor is complete with air intake filter and silencer; on semi-automatic plants an automatic unloader is included which allows the compressor to run light when up to maximum pressure and the cylinder head is fitted with hand unloader gear arranged to open the suction valve and relieve the compressor of load on starting.

It is vee belt driven by $1\frac{1}{2}$ h. p. electric motor wound for the voltage required; a direct on line push button starter with overload protection can be supplied as an optional extra.

The air receiver is suitable for a working pressure of 150 lbs. p. s. i. mounted on the side of the receiver is the air transformer (semi-automatic plants only) and is complete with pressure regulator, pressure gauge, safety valve, drain cock and electric cable.

Working pressure of the semi-automatic model is 100 lbs. per square inch and the fully automatic model 150 lbs. per square inch.

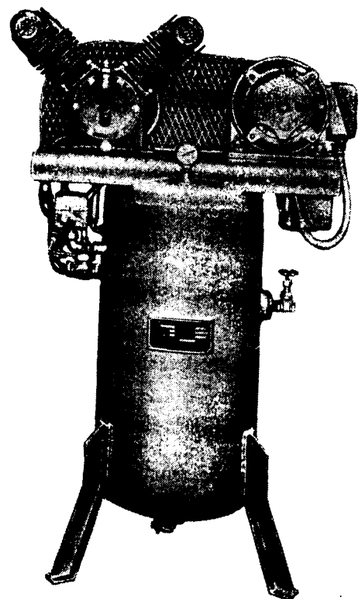
Prices are as follows:

Single Phase Semi-Automatic	£ 99. 4. Od	Sterling.
Three Phase Semi-Automatic	£ 92. 10. Od	
Single Phase Fully-Automatic	£ 99. 4. Od	
Three Phase Fully-Automatic	£ 92. 10. Od	

15V UNIT SPECIFICATION

Effecting a great saving in floor space and occupying only $3\frac{1}{2}$ square feet, this 15 cu. ft. compressor is a further recent addition to the A. I. D. range.

The compressor and motor are saddle plate mounted, this in turn being superimposed on the 3'-0" high ×15" diameter vertical air receiver.



Air Industrial Developments 15 V unit

The vee twin air cooled compressor has 3" bore cylinders and $2\frac{1}{2}$" stroke; and when running at 750 r. p. m. the displacement is 15 cubic feet per minute; it is complete with air intake filter and silencer, and on semi-automatic plants the unloader is included, and this allows the compressor to run light when up to maximum pressure. The fully automatic 15V switches off when up to pressure.

It is vee belt driven by 3 h. p. electric motor, wound for the required three phase voltage, and complete with the necessary switchgear.

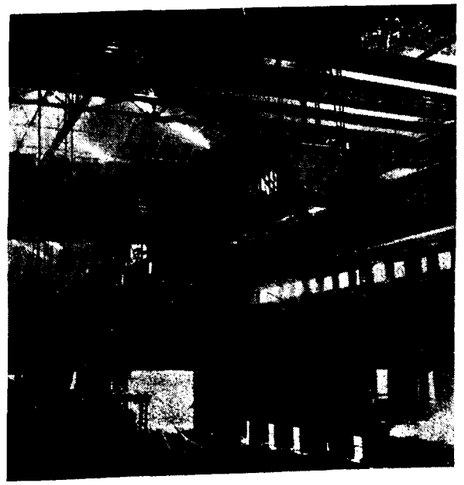
The air receiver is suitable for a working pressure of 165 lbs. p. s. i; and is complete with pressure regulator, pressure gauge, safety valve, outlet wheel valve and drain cock.

Price for three phase semi-automatic unit £ 165. 0.Od. Sterling.

Lysaght's Scunthorpe Works

(Member of G.K.N. Steel Company Ltd.)

OUR Works, originally owned by John Lysaght Ltd. and traditionally known as "Normanby Park", were officially opened in 1912. Initially the Works consisted of three small Blast Furnaces, 4—45 ton Steel Furnaces and Rolling Mill Plant consisting of steam driven 32" Reversing Mills to produce 100,000 tons of Sheet bar per annum. Output rose to 130,000 tons in 1918 and following intense Continental competition and falling prices, it was decided to concentrate on the manufacture of more highly specialised and profitable products, so that in the 1930's a new battery of Coke Ovens was added together with two new Steel Furnaces and other improvements which raised the output to 350,000 tons by 1937.



A view of the Scunthorpe Works

Becoming a separate Company but still a member of the Guest Keen & Nettlefolds Group of Companies, in 1947 major reconstruction commenced, bringing production to over 600,000 tons per annum by the enlargement of the Open Hearth Furnaces to 120 tons capacity and the introduction of a Continuous Billet Mill. In 1952 a Continuous Rod Mill was added with a capacity of 150,000 tons a year. In 1957 another major scheme was started designed to increase

A section of the GKN Steel Plant at work

(Continued from page S.11)

Mechanizing Heavy Foundry Work*

The Story of Plant Operations at American Manganese Steel Division of American Brakeshoe Co., Chicago Heights, Illinois

BECAUSE Hadfield's manganese steel was patented throughout the world in 1883, its competitive manufacture in the United States did not begin until about 1906, when the American Brakeshoe & Foundry Company started production at its Chicago Heights foundry. AMSCO, a pioneer in castings for railroading and construction, entered the field of manganese steel casting only six years after steam railroads installed the first manganese steel frog in the United States.

From the plant's inception, there has always been an east foundry, a west foundry and a side-floor. The east foundry is primarily devoted to railroad work consisting of rails, frogs and crossings, while the west foundry produces castings for the construction industry such as dipper buckets, crusher parts and pump parts. The side-and-snap floor produces miscellaneous castings such as bushings and track shoes.

The Only Answer for Heavy Work—the Slinger

The first mechanization in the company's history took place in the east foundry in the year 1927 when railroads were using an increasing number of castings, but competition for this business was also increasing. AMSCO therefore, had to keep costs down so that their competitive position could be fully retained... mechanization was the answer. Only after careful study a Motive Sandslinger (later replaced by the then newly developed Motive Speedslinger) was chosen to maintain quality and provide higher productivity.

The flexibility problem was eliminated by the wide range of work that could be accommodated by a Motive Sandslinger. Practically all of the medium size work could be Slinger-rammed, and even larger flasks could be handled because the Motive Sandslinger could traverse the bay and move to the work. This initial installation in the east foundry resulted in a man-hour-cost per-ton-of-casting rate that was lower by 50% over previous methods. This Motive Sandslinger set the pattern for the most efficient method of molding manganese steel castings, not only at AMSCO's Chicago Heights plant but in their other plants as well. Slinger ramming greatly helped AMSCO's constant research in the field of manganese steel castings. The harder, more uniform molds resulted in more perfect castings and the Slinger-method of molding became the accepted practice in the production of large manganese steel castings....as it had in the production of molds for all large jobbing work.

Naturally because of the greater capacity of this new equipment a greater strain was placed on the original sand system. A more modern sand system was installed consisting of elevators and conveyor belts which carried

(Continued from page S.12)

output to 700,000 tons annually, a figure reached in 1961. In the same year after alterations in the Rod Mill capacity of this plant was raised to over 200,000 tons a year.

The G. K. N. Steel Company Ltd. was formed in 1962, of which we are one of the three Steel Works, and plans are now advanced to raise steel output to over 900,000 tons annually by the introduction of a separate plant which will include two LD Converters and a Mixer, working initially in conjunction with the present Open Hearth Shop. The annual schedule of production for 1963/64 will be:—

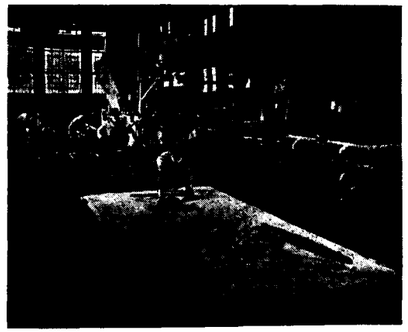
Ironstone	1,800,000 tons
Coke	600,000 ,,
Sinter	1,500,000 ,,
Pig Iron	750,000 ,,
Steel	900,000 ,,
Rods	200,000 ,,

Initially our product was Mild Steel Sheetbar, but now we produce a variety of sizes in Sheetbar, Slabs, Blooms and Billets in qualities varying from Mild Steel Rimming to 1% Carbon and including Silicon, Silico Manganese, Free Cutting and Leaded steels.

the conditioned sand directly to the molding areas. The tremendous efficiency increase obtained by the Motive Sandslinger and the new sand system made management aware that, in the future, hand molding would have to be kept at a minimum to maintain AMSCO's quality, production standards and competitive position.

A SPEEDSLINGER FOR THE LARGEST WORK

The production successes of the Slinger Method in the east foundry paved the way for the installation of a second Motive Speedslinger in the west foundry.



This Motive Speedslinger, the second to be used in the east foundry at AMSCO, has effected great savings. Flasks of various heights and pit molds are all rammed by the Motive Speedslinger.

The west foundry, producing the largest castings made at AMSCO, could not, in a time of rising labor and material costs, keep pace with the east foundry. The large castings were molded strictly by hand and cost-in-line production was not being realized. The west foundry's costs without the slinger were 50% higher than those of the east foundry for comparable castings with the slinger.

With some castings weighing as much as 31,000 pounds, the speedslinger's larger ramming area, and ramming capacity of approximately 20-cubic-feet per minute, were extremely advantageous. Actually, Motive Speedslingers produce molds for castings weighing 100 tons and more. Maximum productivity could be obtained with minimum cost while improving the quality of the castings. The highly accurate castings that resulted were of more uniform weight and of greatly improved surface quality. This meant that in addition to obtaining higher quality castings, cleaning and finishing costs were reduced by 15—20% and scrap losses by 10—15%. Later a Stationary Sandslinger was purchased for the manufacture of miscellaneous molds in the west foundry. This Slinger is still in profitable operation some seventeen years after its purchase.

Molding procedure in both the east and west foundries follow the same basic pattern. There are two types of sand mixes used. Dry sand for manganese steel castings and green sand for other metals. Both are prepared in a newly constructed sand building and are conveyed to the Slingers via belt conveyors.

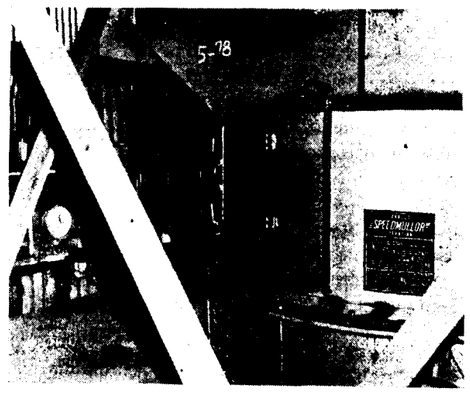
Dry sand molds are rammed and dried one day and poured the next. Two types of ovens are used for drying, a recirculating-type and a jet-type. Molds dried in the recirculating ovens require six to ten hours while the molds dried in the jet ovens require one-and-one-half to four-hours.

Cope and drag flasks are placed and rolled over with an overhead crane. They are Slinger-rammed in a few minutes and then taken to the mold drying ovens by an overhead crane. Following the drying, the molds are set beside the ovens where they are poured the next day. After pouring, the overhead crane takes the molds to the shakeout areas which are located at the end of both the east foundry and the west foundry.

From the shakeout the castings are again moved by overhead crane to the heat treating ovens. All manganese castings are heat treated to a temperature of 1,050°C to assure hardness.

The Side-and-Snap Floor

The smaller side-and-snap floor molds are all green



This 80A Speedmullot with Mulltrolmatic control is in constant use preparing sand for both the east and west foundries of AMSCO.

sand and are molded and poured on the same day. Match plate patterns are used on most molds, but loose patterns are also encountered. The snap flask molds and intermediate molds are poured on rollers while the larger molds are set on the side floor and poured on the spot. Sand from the Model '70' Speedmullor is conveyed by belt to hoppers above jolt and jolt-squeeze machines, and all of these machines are supplied with this Speedmullor sand.

The New Speedmullor Sand System

One of the outstanding features of the new sand system is the anti-segregation tubing leading from the bins to the hoppers above the mullers. These tubes are designed to combat storage segregation and eliminate the breaking up of preselected sand mixes. In ordinary distribution, sand from the center of the hopper will always fall first leaving sand along the side of the hopper to fall at a later time thereby breaking up the mixture of coarse and fine grains. But, regardless of the segregation that occurs within the bin, the outlet pipes re-blend the sand to a distribution more-or-less the same as specified when the sand was purchased. This is done by placing the outlet tubes at various intervals along the bottom of the bin to insure equal flow from all parts of the bin.

Much better control is achieved with this anti-segregation distribution. Each grain of sand, whether new or reclaimed, is distributed to the mullers by this method. More uniform or consistent sand fed into the sand preparation and distribution system, results in a greater degree of consistency in molding characteristics of the prepared sand mixes, and therefore greater consistency in cast surfaces.

While all features of the new sand system are important, the heart of any commercial sand system is the mulling...and AMSCO chose a Model "80A" Speedmullor for the mulling of their molding sand. This Speedmullor, automatically controlled by Mulltrolmatic, provides a capacity of upto 76 tons per hour and is in constant use providing both the east and west foundries with fully developed molding sand. The choice of the Speedmullor was based on its exceptional capacity and its ability to uniformly develop the fullest physical properties in the shortest time cycles. The second muller is used for preparing facing sand.

The majority of the metal poured at AMSCO is manganese steel and the balance is chromium, chromium-molybdenum and other special steels for certain special castings such as cutter heads. All AMSCO plants supply variations of the standard manganese steel, which may contain additions as chromium and molybdenum.

The Motive Speedslinger's great ramming capacity and flexibility have added greatly to the productive efficiency of the west foundry. Here the slinger is ramming a mold at a twenty cubic foot per minute rate.

The rigid quality control at AMSCO dictates that every heat be analyzed in their modern laboratory facilities. Bars from each heat are kept for a specified period of time and borings of each heat are kept perpetually so that there is a record of the exact properties of each heat produced.

Flexiblos in the Core Room

The mechanization and modernization at AMSCO has not been limited strictly to molding sand preparation and distribution. Increased use of more intricate castings places a greater burden on the core room and this facet of the foundry operation which is often de-emphasized during modernization programs, has not been neglected. AMSCO has installed a CB-5 Flexiblo Coreblower for the production of smaller cores, a Model '40' and a Model 155 San-Blo Coreblower and most recently a CB-10 Flexiblo. A review of cores now being produced manually is underway and the possibility of purchasing additional Flexiblos is being explored so that even greater cost advantages can be realized.

It is constant attention to detail that has made AMSCO one of the leaders in its field. Not only do they produce some of the largest manganese castings in the world, but their dedication to the production of castings of the highest quality has gained a reputation for effective operation and craftsmanship.

*Condensed from BETTER METHODS – July–August 1961

JOSIAH GUEST INSTALL URQUHART OIL-FIRED FURNACE FOR PRODUCING ROLLS

GREAT advances have been made in the last decade in the production techniques and plant and equipment used in the steel industry. For certain applications in steel sheet mills there has been a gradual decline in the use of cast iron for mill rolls in favour of steel base rolls.

Josiah Guest & Sons of West Bromwich, Staffs, old established foundrymen, are acknowledged experts in the manufacture of cast iron rolls. Some of their furnaces, however, were only suitable for cast iron and were hand-fired with solid fuel without any form of temperature indication or control; so a new furnace was planned, suitable for the melting of both steel base and cast iron rolls and with semi-automatic oil firing, remotely and automatically controlled in several functions.

Considering the specifications of the proposed furnace Guests decided that the melt capacity would be 10 tons and the fuel oil to be used would be a heavy grade, 960 seconds Redwood No. 1 viscosity at 100°F. For high duty cast iron rolls the furnace would work with a reducing atmosphere throughout the melting cycle with, for steel base rolls, provision for an oxidising atmosphere. The 10 tons melt would take 6-7 hours with a target fuel rate of 40 gallons per ton melt.

The design specified was a top loading reverbatory with alternative water-cooled side doors, remotely operated through pneumatic power cylinders, for loading returned rolls straight into the furnace from transport. A gantry crane has been installed for this purpose and also for lifting off the appropriate roof section.

Urquhart's (1926) Ltd. of Greenford, Middlesex, were awarded the contract to design, supply and install the furnace, combustion equipment and controls. They appointed The Furnace Construction Co. Ltd. of Birmingham as sub-contractors for the construction of the actual furnace and close co-operation was maintained at all stages to ensure full integration of the design of the furnace and oil-firing equipment. The same sub-contractor also repiled the foundations to take the new furnace and the steel work which they erected to house the recuperator.

RECUPERATOR

The recuperator had been previously acquired by Josiah Guest—an INKA radiation supplied by Newton Chambers & Co. Ltd.—and Urquhart's incorporated this into the general design. This unit preheats the combustion air to approximately 350°C. The design is such that to remove the tube bundle and exhaust duct a gantry duct had to be installed. The steel frame housing supporting the recuperator also accommodates a gantry crane, exhaust duct and combustion and cooling air fans. The fans inject cold air into the waste gases at exit from the furnace in order to keep them below 1300°C as they enter the recuperator.

OIL BURNING EQUIPMENT

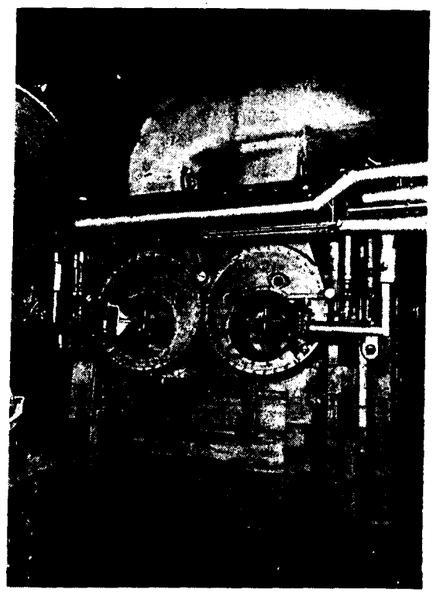
Certain of this equipment had also been installed before Urquhart's were awarded the contract, including an oil ring main pumping and heating installation, to which only minor modifications were made. It was found necessary to add boost pumps, primary air compressors and combustion air fan, for a calculated absolute maximum fuel consumption of 120 gallons per hour.

To give maximum heat distribution over the melt two Urquhart Type SFF. 7 Atomisers are used, each mounted on universally swivelling fixings enabling the angle of firing to be adjusted by 2½° in any plane. The air registers, utilizing pre-heated air from the combustion air fan via the recuperator are designed to give maximum mixing of combustion air and fuel, by injection of air into the atomised fuel spray. Altough air is supplied from one source there are trimming dampers on each air register to ensure equal distribution.

To provide atomising air for the twin M. P. A. atomisers three air compressors were installed giving 50% standby. The boost fuel pumps are Urquhart designed and manufactured variable angle swash-plate metering pumps. In this case they combine the function of boosting pressure with that of a completely positive control valve. Three pumps are installed, again providing 50% standby capacity. In addition there is a by-pass system so that the pumps can be excluded and the burners operated on ring main pressure in an emergency. All compressors and pumps are housed in a specially built control room with the control panel.

CONTROL SYSTEM

This can be divided into three parts: (a) Temperature and atmosphere control (b) Furnace pressure control and (c) Recuperator inlet waste gas temperature control.



The atomizers and air registers at the front of the furnace

(a) A radiation pyrometer in the side wall of the furnace and sighted on the furnace crown transmits to a temperature controller. This temperature controller in turn puts out a pneumatic signal in the range 3—15 p. s. i. g. to both air flow and oil flow controllers. The air flow controller adjusts a valve in the combustion air duct to the recuperator by means of a pneumatic power cylinder. The oil flow controller adjusts the output of the oil metering pumps by variation of their swash-plate angle, through a pneumatic power cylinder, and cam shaft.

Oil and combustion air flow is then checked and trimmed by feedback through measurement of air and oil flow. A variable ratio mechanism is provided to allow for the requirement of an oxidising atmosphere when melting steel and reducing atmosphere when melting cast iron. Provision is made for over-riding manual control to be carried out.

(b) To ensure that the furnace operates under a slight positive pressure a furnace pressure controller is fitted which controls the

A general view of the side of the furnace, showing the recuperator (top left) and the combustion air duct (top centre) from the recuperator to the air registers

position of a damper in the exhaust duct on the discharge side of the recuperator through a pneumatic power cylinder.

(c) A thermocouple positioned in the entry of waste gases from furnace to the recuperator measures the gas temperature and through a temperature controller adjusts the quantity of cooling air injected into the gas stream by variation of a damper, in the duct from a cooling fan, connected to a pneumatic power cylinder.

To provide the instrument air supply necessary a compressor set is included, comprising one working and one standby compressor both feeding one air receiver, installed in the pump and compressor control room. The instruments to effect the controls described are all mounted on a free standing panel, visible from outside the pump room.

Fitted into a sub panel on this main panel are all push buttons and indicating lights to operate all of the pumps, fans and compressors installed.

A full light alarm system is incorporated for immediate indication of the source of any fault, and apart from the actual lighting up of the furnace all other starting up or shutting down and control operations may be carried out by one man from this control panel. All instruments used, and the main panel etc. were supplied by George Kent Ltd.

Budapest Industries Fair Supplement

THE 1962 BUDAPEST INDUSTRIAL FAIR

IT was in 1906 that the first industrial fair was organized in Budapest and so the Hungarian capital was the third among the European cities to arrange for a Sample Fair. Ever since—not counting forced breaks during the two world wars—the Budapest Fair has been organized year by year, these last few years under the name of Budapest Industrial Fair. The significance of the fair is growing—it represents more and more a cross-section of the Hungarian industry and an ever rising number of foreign exhibitors bring their goods to Budapest. Accordingly the area of the Fair has undergone an increase, as far as warranted by possibilities: in 1961 it expanded over a maximum area of 260,000 sq. m. The present traditional spot where the Fair is held does not allow for further expansion but the new Fair City. on the Buda Embankment, in the South of Budapest, is already being built where the most up-to-date circumstances will call for a further large-scale development of the Budapest Industrial Fair.

Site preparations have already begun for the Budapest Fair this spring. Repair and extension work is being carried out on the pavilions, and the Bureau for the Fair is impelled to work all-out by the fact that greater foreign interest is being shown in the Fair.

The Fair is always held in the second half of May. This year it will open its gates on May 18th to admit visitors until May 28th, i. e. over eleven days.

Here below we would like to mention some rather noteworthy novelties among the exhibits :

The exhibition of the heavy industry features especially the importance of the chemical industry, displaying beside crude oil refinery equipment different crude oil products, man-made materials, synthetic rubber. Like in the last years the pharmaceutical industry will appear with a number of new products, the rather developed aluminium industry of Hungary will be represented by a multitude of articles, not to mention mining machines of which some internationally outstanding types will be exhibited.

Also the metallurgical and engineering industries will come forth with quite a few new products, primarily in the field of machine-tool and instrument manufacture. The exhibits of the telecommunication industry will include chiefly modern export articles. Besides ORION products, a brand known all the world over, also radios and TV-sets manufactured by other works will be displayed. The Fair being located on the shores of the City Park Pond, it will offer a good opportunity for the Hungarian shipyards to show their latest models.

The building industry will exhibit modern structures and novel-type materials employed in residential construction on the industrial scale.

The exhibition of the light industry will be featured by both interest and diversity, and will include almost the full range of its products : furniture, clothing articles, silks, woollen cloths, synthetic fabrics, fancy leatherware, shoes, etc.

Hungary's industrial exhibition will cover about half the area of the Fair, the other half being reserved for the use of foreign exhibitors. Last year exhibitors from 20 countries appeared—this year their number is going up to 22.

Half the participating foreign countries will avail themselves of the pavilions they occupied last year, the new exhibitors will erect new pavilions. The former group includes Austria, the Soviet Union, Poland, Czechoslovakia, the German Democratic Republic, Bulgaria, Yugoslavia and France, the latter consists of Finland, Cuba, Italy, and Belgium. Some Italian firms exhibited also last year but Finland and Cuba are newcomers among the exhibitors. The former will display her famous wood and paper industries whereas the visitors to the Cuban pavilion will get acquainted with agricultural products.

Also the German Federal Republic, The Netherlands and Romania will be official exhibitors : these countries propose to set up information bureaus.

From other countries individual entrants have registered, thus from Great Britain, from Denmark—to be represented by telecommunication and precision enginerring product—, from Switzerland—the Swiss firms will exhibit machine tools, instruments, watches, etc —, and from Japan, which will also be represented for the first time in Budapest. As a matter of fact Japan's participation seems to be rather wide-scaled : quite a number of firms will hold an exhibition on an area of about one thousand sq. metres. Among others the exhibits will include portable TV-sets, transistor radios, chemicals, products of the electrical industry, cloths of staple fibre, etc.

The organisers of the Fair have done their best to apply modern ideas and to develop it soon into a Sample Fair, based on the principle of specialisation. As far as possible, this idea of specialisation will be adopted already this year, and the Fair will include the following specialised exhibition groups :

" Machine-Tools "

" Precision Engineering "

" Telecommunication "

" Motor Vchicles "

" Paper and Printing "

" Furniture and Furnishings "

" Textile and Clothing "

" Leather—Furs—Shoes "

This kind of specialisation is likely to contribute to the quick orientation of experts and other visitors interested in the Fair.

MACHINE TOOLS AT THE BUDAPEST FAIR 1962

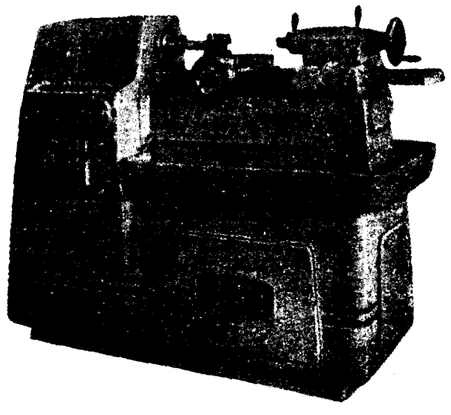
By E. Füzi – Budapest

THE Budapest Fair having a tradition of 50 years plays an important and remarkable part both in establishing and extending international relations and in developing Hungarian industry. The fair growing wider, richer and more beautiful year by year ; displays the most outstanding products of Hungarian industry and allows specialists to study the machines presented at the Fair and to collect valuable experiences.

The Budapest Fair 1962 and the exhibition of machine tools forming a part of it show the latest and most interesting designs, some of which are described in the following.

The latest product of the Kobanya Machine Tool Factory, *High precision tool makers' lathe type EKM-200* has been specially developed to suit the requirements of super high-precision machining in the optical industry, precision engineering and instrument manufacture.

The spindle is nitrated and possesses superfinished bearing surfaces ; it is mounted in two plain expansion bearings of a special design founded upon the theory of hydrodynamic lubrication. It is lubricated by means of a separate supply unit. Its starting is electrically delayed until the entire oil film is formed. Axial runout is compensated by an interposed elastic member. The spindle drives onto gears only during thread-cutting operations, this drive being disengaged during fine turning in order to separate the spindle from elements causing vibration. The leadscrew is located along the centre of the bed and is completely protected against chips. The lathe may be used for turning bar-and disc-shaped work-pieces for thread-cutting as well as for precision drilling when the workpiece is clamped into the saddle designed as a table.



High precision tool makers' lathe type EKM-200

The main features of the lathe are close tolerances /IT 5/ and high surface quality /0.2—1.0 mikron/ of the parts machined on it furthermore easy service, reliable operation and attractive form.

Stand and bed are cast integral and developed so that the components of the auxiliary drive and leadscrew may easily reassembled. The saddle designed as a table of rigid construction slides on flat and vee-shaped slideways protected by specially arranged plates. Lubricating discs ensure proper lubrication.

The main drive operated by a two-speed Dahlander motor and four magnetic clutches offers 6 different speeds. The low speeds used for thread cutting are obtained through an inbuilt hand-operated transmission. The two-speed motor ensures an increased speed range.

The operation of the machine is greatly facilitated and simplified by push-buttons mounted on the control board. It is this control board where the selected speeds of the gearbox can be engaged feeds shifted on and off and the main spindle braked. Comfortable and easy handling is ensured and improductive time reduced by the one lever control which serves for reversing the sense of rotation of the main spindle e. g. for thread cutting and by the rapid traverse of the saddle in both directions even while the machine is running.

A further advantage is offered by providing automatic engagement resp. disengagement of feeds when rapid traverse of saddle is started resp. stopped.

A cut-out device accommodated on the bed, which permits to set longitudinal stops of any dimension makes turning to size easy, especially for the machining of shafts with shoulders. A large number of standard and extra accessories widen the field of application of the machine. Some technical data of the lathe to serve your information :

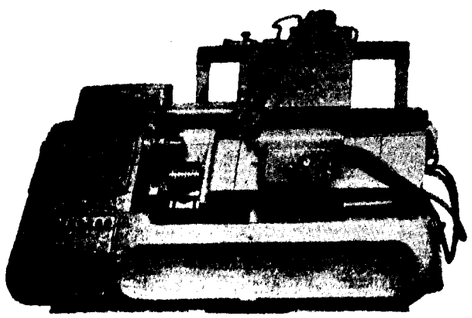
Maximum swing over saddle	200 mm
over traverse carriage	120 mm
Distance between centres	350 mm
Range of spindle speeds	67—3000 r. p. m.
Range of feeds	0.005—0.115 mm per rev.

Another valuable product of the Kobanya Machine Tool Factory

Lathe with diamond tipped tools type EGM-200 is a simplified member of the family of super-high precision lathes specialised for fine turning.

Another interesting machine is *Automatic copying lathe type EM-500/320* designed and developed by the Institute for Machine Tool Development.

The prototype of this machine was already shown at last year's Budapest Fair. Now it is presented as a member of the 0 series by the manufacturing works, the Metal Products and Machine Tool Factory. This improved machine of an attractive design has been provided with work feed and out-off slide to make an excellent up-to-date type copying lathe. The main technical data are essentially the same as those of the prototype displaced last year. According to the specifications the lathe is manufactured with 500, 750, 1000 mm distance between centres executions.



Automatic copying lathe type EM-500/320

The maximum swing to be machined between the centres is 320 mm. Disc-shaped workpieces can be machined up to a diameter of 500 mm.

Metal Products and Machine Tool Factory present their universal lathe Type EU-630 manufactured in series, the programme controlled turret lathe Type RT-80-P and the programme controlled automatic production lathe, Type ETP-500 exhibited as prototypes last year.

The Institute for Machine Tool Development presents

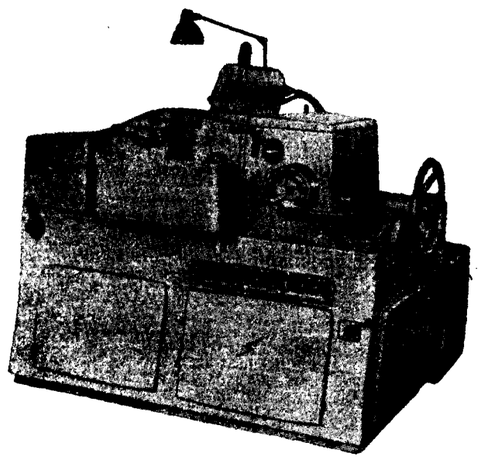
AUTOMATIC TURRET LATHE TYPE RTA-160

Budapest Machine Tool Factory shows *Centreless grinding machines. Type KCN-25 and Type KCH-63* manufactured in series by the above firm.

These machines have proved most economical in the machining of cylindrical, tapered and profiled workpieces made of steel, non-ferrous metals, plastics and other materials. The precision of machining fully meets the requirements set both by users and by modern technology. Some of the most characteristic technical data :

Grinding capacity : diameters	1 to 25 and 3 to 65 mm, resp.
max. length for plungecut grinding	95 and 120 mm, resp.

Number of control wheel speeds for both machines.



Centreless grinding machines, Type KCN-25 and Type KCH-63

MILLING MACHINES

Universal and vertical milling machines feature high on the manufacture list of Hungarian machine tool industry. It is Csepel Machine Tool Factory and Esztergom Machine Tool Factory that have specialized for their series production.

Several of these machines made by Esztergom Machine Tool Factory will be exhibited at the Fair.

UNIVERSAL TOOL MILLING MACHINE, TYPE MSU-250

has been designed to meet the highest requirements raised by tool manufacture. Its construction makes the machine suitable for machining plain surfaces of various angular positions as well as for slot milling, and other milling jobs with great accuracy. A vernier with 0.02 mm divisions assures the precision required in tool and fixture machining.

The main spindle speed and feed stages allow the application of a great variety of tools and the setting of the most advantageous and productive machining values.

The basic worktable of the machine can take stationary and tilting tables, an indexing device and a spiral milling attachment.

The control of the machine is simple and easy. The speeds and feeds are set with individual levers. The main spindle is started and stopped by push buttons.

Standard and extra accessories make the milling machine suitable for a great variety of jobs.

INFORMATIVE TECHNICAL DESCRIPTION :

Basic table	250 × 800 mm
Longitudinal and vertical travel of basic table	420 and 400 mm
Speed range of main spindle	45 to 2240 r. p. m.
Number of speeds	18
Feed range	10 to 400 mm/min.
Number of feeds	17

AUTOMATIC INDEXING HEAD, TYPE AO-160 manufactured by the Csepel Machine Tool Factory is an accessory of the program-controlled milling machine, Type MUP-320. At the Fair the indexing head will be shown assembled on the milling machine. The use of the indexing head eliminates manual division. The device lends itself for all operations falling within the field of application of universal indexing heads, such as differential indexing, straight and spiral milling, etc. Actuated by a push button the tailstock clamps and unclamps the workpiece without any manual effort. Apart from work change, the operation of the indexing head is fully automatic and the machine stops when the required indexing and milling process has been completed.

TECHNICAL INFORMATION :

Indexing range	2 to 400 divisions
Height of centres	160 mm
Swing	—10 to + 90 deg.

CUTTING-OFF MACHINES

Csepel Machine Tool Factory will exhibit hydraulic circular saws and

PLASTIC DISC CUTTING-OFF MACHINE, TYPE DEM-500

The machines not discussed in this short report but to be found at the Fair include single-purpose machines, aggregates and other machines processing the workpieces with and without cutting.

Suppliers of all the machines mentioned are TECHNOIMPEX Hungarian Machine Industries Foreign Trade Company, Budapest V. Dorottya-utca 6—P. O. B. 183 Budapest 62—Cable Address : TECHNOIMPEX.

AMMETER FACTORY BUILT WITH HUNGARIAN ASSISTANCE

An ammeter factory built with the collaboration of the Hungarian Ganz Ammeter Factory and the Indian Sanghal Company was inaugurated in Chandingarh in India. The Ganz Ammeter Factory contributed to the work by supplying the technological documentation and by sending specialists to organize the manufacturing process and to train the workers. For the time being the production of ammeters is still carried on with Hungarian parts, but the manufacture of the components themselves will also be started soon. The Ganz Ammeter Factory entered into a contact with the Indian partner for an annual production of 50,000 ammeters, but, experiences shows that the factory will be able to double its capacity.

HUNGARIAN MACHINE TOOLS IN INDIAN PLANTS

By A Special Correspondent

LIVELY commercial relations established in the course of the last years between the Hungarian People's Republic and the Republic of India are being further extended thanks to the speedy development of Indian industry, agriculture, mining and communications. Hungarian machine tools are shipped in ever increasing numbers to industrial plants in India.

Specialists of India are already familiar with several types of Hungarian built machine tools. Thus, for instance, the Universal Lathe type MVE-340 is a modern tool produced at the Metal and Machine Tool Works of Budapest. Vibration-free construction and amply dimensioned elements render this machine suitable for machining with carbide or ceramic tipped tools. The machine also lends itself for heavy duty roughing and for the finest finishing jobs. Motor power and speed range fully meet the requirements of economic cutting. Fitted with a hydraulic copying attachment, the machine can reproduce the most intricate pieces. An operating lever of modern design enables the operator to handle the machine without moving from his place. In addition to the hydraulic copying attachment a number of accessories complete the machine.

Type RT-40 is the best known of Hungarian turret lathes in India. This machine has been developed by the Budapest Machine Tool Works from an earlier model : the Universal Lathe Type E-400, by retaining and developing the outstanding features of the basic machine. A wide range of speeds make this machine

particularly suitable for economic performance of roughing and finishing jobs and, fitted with the proper tools, for turret lathe jobs. Down times are reduced by extra attachments, among which mention in the first place is due to the mechanically actuated bar chuck which facilitates and expedites clamping and feeding of the piece in addition to saving labour. Type RT-80-P is a programme-controlled version of the turret lathe RT-40. Up to the present, this particular design has not yet been bought by India. The 12 main spindle speeds required for setting up the machine, performing specific operations or series machining with punched card control are preselected in an arbitrary sequence within the range of 12 available main spindle speeds with a hand actuated electrical device. Eight different saddle and slide feeds can be preset or programmed on punched cards for the feed box and further readjusted on the apron drives as required for the roughing or finishing job on hand. Type RT-80-P belongs to the class of semi-automatic machines.

A great variety of drilling machines are manufactured in Hungary, two types of which, Radial Drilling Machines Type RF—31 and RF—51 are being supplied to India. The first is designed for drilling operations in medium and larger pieces, the latter for machining heavy, bulky pieces.

Several types of Hungarian made grinding machines are also operating in India. Among them the Universal Tool Grinder KSU-250 which—supplemented by standard and extra accessories—is used for universal and special tool grinding jobs. Versatility and high precision are the main features of this machine.

The Universal Cylindrical Grinder Type KU-250 is designed for internal and external face grinding, surfacing jobs, for developing long flat and short steep tapered surfaces.

Another Hungarian machine tool known in India is the Diamond Wheel Tool Grinder KG-150, designed for the grinding and lapping of single-point carbide-tipped cutting tools. The double disc serves the purpose of carrying out the grinding operation with one and the lapping operation with the other disc. The discs operate with the face and may be either single—or double—faced. Extra accessories for performing certain special jobs have been designed for this type of machine, too, namely for grinding milling cutters with inserted tips, chipbreakers and radii, or cutting to size carbide tool tips, with using smooth saw discs.

Recently Hungary has shipped to India the first Centreless Grinding Machine Type KCH-63, used with standard and extra accessories for precision machining of cylindrical or tapered pieces made of steel, non-ferrous metals, plastics, etc., also for through-feed and infeed grinding of bars and individual pieces. Operation of this machine is particularly economical in the fabrication of medium and large series. Dressing of the grinding and infeed wheels in hydraulically controlled.

The Universal Milling Machine Type ME-1000 has been the object of earlier shipments to India, while exports of the MUP-320 type of the same machine tool have just started. Both designs have some remarkable modern features. The first type is manufactured in standard and high accuracy models extensively serviceable for cutting smaller pieces. Its design and ease of maintenance have been developed for application both in individual and in series production. Thanks to an exceptionaly wide range of speeds, the machine is capable of cutting all kinds of steel, non-ferrous, light metal, etc. pieces at the most economic speed. Tool or HS-steel, as well as carbide-tipped tools can be used arbitrarily.

The Universal Milling Machine Type MUP-320 now presented provides means for a wide diversity of cutting jobs. In addition to operations commonly performed on knee-type milling machines, it can be used in cycled and programme-controlled production. High accuracy is ensured, among others, by table elements stopping within a tolerance of ± 0,03 mm, regardless of the speed.

Flat, circular, square, Tee, L-section and bend steels are being cut, steel strips, sheets and plates up to 16 mm thickness are being punched in India with Hungarian made Shape Shears Type OP-20. The machine frame is welded from high tensile steel plates, all shafts run in bronze bearings. The machine can be readjusted by hand for the production of individual pieces or series.

The examples quoted above illustrate the multiplicity of machine tool exchange between India and Hungary. Parallel to the widening of commercial relations between the two countries increases the variety of machine tools furnished.

Development of Some Major Hungarian Industrial Branches in the Post-War Period

IN the years following the Second World War, Hungary launched a policy which still continues today, of realizing large-scale industrialization. Industrial investments, growing from year to year, were made within the bounds of this plan. Industry, as a sector of the people's economy advanced at a rapid pace and took in a role of growing importance—a fact manifesting itself in many characteristic and comprehensive indices of economic life. Take, for example, the number of people employed in industry, as compared to the total of earners. The proportion rose from 18 per cent, in 1949 to 26 per cent, in 1960, while the share of industry in the production of the national income grew from 43 per cent, to 59 per cent. As result of all this, there was a similar growth in the importance of the industry as related to foreign trade. One of the facts which demonstrate this development, is the share of industrial products in the total of Hungary's exports : it rose from 57 per cent, to 79 per cent.

This increase in the importance of the place occupied by industry, is expected to continue. According to the provisions of the Second Five Year Plan covering the period 1961—1965, besides an increase in the national income, reaching 36 per cent, the volume of industrial production is due to rise by some 50 per cent.

Parallel to the boosting of the production volume, the industry will undergo a very considerable structural change : Within industry as a whole, progress, for quicker than the average, will be made in branches where, because the profile responds to the home production preconditions, production will be more economical. The fact that Hungary is short of certain raw materials but disposes of a skilled labour force and technical people, are the factors making it pay to concentrate every effort on furthering production in industrial branches demanding high working intensity : mechanical engineering, telecommunication, instrument making industries. A notable quantity of these products goes to export, at the same time many kinds of raw materials are obtained through imports, quite regularly.

We intend to devote a series of articles to the main branches of Hungary's industry, reporting on their post progress, and plans for the future. In the first place, we shall deal with those branches, where the international division of labour plays an important role. This will also reflect those industries which import their raw materials and semi-products from abroad and export a very high percentage of their final-products.

AGRICULTURAL MACHINERY AND MEANS OF COMMUNICATION

Mechanical engineering in Hungary is one of the branches of industry undergoing very quick development. Taken on a net basis, its production increased by 4.13 between 1949 and 1960. (During the same period the increase index of the whole state industry, essentially the manufacturing industry, was 3.31.)

Within mechanical engineering it is the manufacture of means of communication that is at the top of the table—seen from the point of view of the number of workers employed and of the yearly aggregate of production. The major part of capital equipment for mechanical engineering is in the possession of works manufacturing means of communication.

Data of Major Importance on Mechanical Engineering in 1960

Number of workers and employees by 1000	p. c.	Gross value of production million Ft	p. c.	Gross value of capital equipment mill. Ft	p. c.
Machinery, total					
186.4	100	27 220	100	16 680	100
Hereof					
Manufacture of means communication					
77.6	42	12 995	48	7 730	46
Repair (maintenance) work on means of communication					
27.9	15	2 944	11	1 961	12
Agricultural machinery production					
11.4	6	2 082	8	717	5

(Statement Contd.)

Number of worker and employee by 1000	p. c.	Gross value of production million Ft.	p. c.	Gross value of capital equipment mill. Ft.	p. c.
Manufacture of machine tools					
8.4	5	903	3	854	5
Production of machinery and equipment for light industry					
6.3	3	536	2	344	2
Manufacture of mining machinery					
5.8	3	829	3	579	3

* At the time of going to press the 1961 data were not yet available

The range of means of communication produced in Hungary is very wide, including many kinds of the most important means of communication, except those of air traffic. To this group, playing an important role in exports as well, belong means of communication of railway traffic. Gradually as steam locomotives became obsolete their production fell back until it was finally given up in 1960.

Production of Several Means of Communication of Major Importance

	1955	1959	1960
Steam locomotives	1950	5	—
Steam locomotives for narrow-gauge railway lines	19	—	—
Electric locomotives for narrow-gauge railway lines	18	43	3
Diesel locomotives	4	132	124
Railway motor coaches	38	43	35
Railway passenger cars	296	407	493
Railway load trucks, containers and special wagons	566	363	551

Great importance is ascribed to means of railway communication, also in Hungary's foreign trade. In the first place, railway motor coaches and Diesel locomotives, which have been going to export in the recent years. Imports have been mainly in railway load trucks and wagons (4630 pieces in 1960).

Another important item on Hungary's export lists are the various road vehicles. Among them, special attention is being paid to buses and trucks. In 1960 some 1900 buses were manufactured in Hungary, i. e. 11 times as many as in 1949, surpassing the 1955 production level by about 40 per cent. Hungarian buses are well-known all over the world and are much in demand. First place in production is the bus for export purposes, the 1960 exports of buses came up to 62 per cent of total bus production. Exports of buses are, in the first line, to European countries, but there are some non-European countries among the buyers.

Distribution of Hungary's Bus Exports Among the Main Buyers

	1958	1959 (in pieces a)	1960	p. c.
Total	1088	1054	1192	100.0
Bulgaria	6	53	41	3.4
Czechoslovakia	32	1	1	0.1
Greece	1	5	—	—
Yugoslavia	119	138	75	6.3
Poland	158	62	149	12.5
German Democratic Republic	413	461	748	62.8
Soviet Union	206	263	22	1.8
Burma	2	—	—	—
China	105	2	61	5.1
United Arab Republic	36	9	—	—

a) Including bus chassis exported separately (1960 : 12 pcs)

Viewed through the figures of the last two years, truck production shows a moderate setback. This is, however, a temporary phenomenon and is due to a structural change in the profile of this production branch. In this period Hungary's road truck making industry turned from the manufacturing of standard road trucks in series (the only way to make their production economical) and began, step by step, to bring out special trucks, their production being—even in short series—very profitable. Exports also take first place in the manufacturing of road trucks.

Nikex Supplies the Chemical Industry

THE heavy chemical, pharmaceutical, dyestuffs, food and plastics industries rely on equipment which permits the processing of corrosive materials and the carrying out of various chemical processes mostly at high temperatures under increased pressure values.

Specialists agree that the contemporary answer to these problems is an apparatus built of acid-resistant enamelled steel-plates, since it provides a markedly higher degree of resistance to corrosion than alternative equipment made of more expensive non-ferrous metals, and is at the same time heat and pressure-resistant, easy to clean, convenient to handle and reliable in service. As an additional advantage, it eliminates metallic contamination of the materials processed and prevents the catalytic action of steel.

It can safely be said that the ideal structural material for building such apparatus for the most varied purposes is steel coated with acid-resistant enamel.

Moreover, chemical works are generally in need of such apparatus and equipment which, besides satisfying the above outlined requirements, lend themselves to manifold applications and to readjustment according to the varying requirements of production. Another important consideration, partly from the point of view of ensuring continuity of production and partly for reasons of economy is a reduction of the number of kinds of machines and parts kept in stock.

The construction of apparatus and equipment meeting these requirements in every respect imposes no small task on the designers, specialists, engineers and technicians. The close contacts and co-operation maintained for long years with all branches of the chemical industry, as well as continuous, extensive research and experimental work have enabled *Nikex* to put a number of apparatus series at the disposal of the chemical industry which fully satisfy the demands made on them. *Nikex* is also in a position to supply special equipment and individual constructions to cope with tasks that cannot be resolved with the series-produced apparatus.

Acid-proo enamel-coating resists the corrosive action of all acids, acidic solutions and their vapours, with the exception of hydrofluorid and commercial phosphoric acid containing fluoride impurities.

Taken at random from the generous range available, a universal-purpose serial apparatus is described in the following terms :

The apparatus under review are designed for 2.5 or 6 atm. chamber pressure and 6 atm. heating muff pressure for use up to a temperature of 165° C. Mixer speed is 50 revolutions per minute. Failing contrary specifications, the apparatus is supplied with an enclosed, externally muff-heated electro-motor of 380/220 voltage. A pulley drive can, upon request, be substituted for the motor drive. The outlet pipe end is optional.

The same type of apparatus is also available without an outlet pipe end and with a smaller number of pipe end and inspection windows on top, with 100, 250 or 500 litres capacity, for 10 and 16 atm. chamber pressure.

In addition to the autoclave-mixer *Nikex* manufactures the following types of apparatus from acid-resistant enamelled steel plates :

Laboratory autoclave-mixers for 2.5—6—10 and 16.atm. working pressure, 6 atm. heating steam pressure, 165° C max. temperature, with 30 to 50 lit. capacity.

Distillation equipments with autoclave-mixer in various combinations, for 1 atm. working pressure, 120° C temperature, with 30 to 2000 lit. capacity.

Pressure-filters for 2.5 atm. working pressure, 6 atm. heating steam pressure, 165° C temperature, for carbon clarification in intermittent and continuous operation.

Crystallizing and storing vessels of 100 to 2000 lit. capacity.

Evaporating pots with or without mechanical mixing, for 6 atm. heating steam pressure, 165° C temperature, with 100 to 2000 lit. capacity.

(Continued from page B.11)

Road Truck Production and Export
(Including dumpers)

	Production	Units Export
1949	996	—
1955	3664	2064
1956	2970	1594
1957	3002	2291
1958	3821	2987
1959	3404	2191
1960	2918	2535

Other very important products of Hungary's road vehicles making industry are the motor-cycle and bicycle. Both products were manufactured in considerable quantities and exported before the Second World War. Hungary's production of motor-cycles reached the total of 57,523 pieces in 1960, i. e., 32 times more than in 1938 and nearly 6 times the 1949 total output. In 1960, the export of motor-cycles was over 21,000 pieces.

Bicycle production reached 256,000 pieces in 1960, the export of the same year was more than 61,000.

Hungary has long traditions in the manufacturing water craft. This production line has worked itself up to a very high level. Hungary's shipbuilding industry is building, in the first place, passenger ships for river traffic, towing craft for river use, cargo boats for inland waters and seagoing cargo vessels as well as floating cranes of various capacities.

A very high percentage of the water craft output goes to export. Thus, e. g., the major part of the 5 ton floating cranes (nearly 90 per cent) and that of the 100 ton floating cranes without exception, went to buyers abroad in the past three years. Similarly, the production of passenger and cargo ships is chiefly aimed at furthering export purposes.

The manufacture of *agricultural machinery*, regarded by its volume or, by the importance to be attached to it, within mechanical engineering as a whole, ranks second to the means of communication. Though second importance as compared to the other branch, agricultural machinery production holds a headway place in the economy of Hungary, because its production and development exert a far-reaching influence on the progress of the national farm mechanization targets.

HUNGARIAN FOREIGN TRADE

(Yugoslavia, Argentina, Brazil)

THE following is the last in a series which will discuss Hungary's foreign trade statistics. Its aim is to provide the reader with information on the exchange of goods between this country and her most important trading partners as well as on the developments on the volume and composition of the turnover. Each article will deal with only limited number of countries taken in alphabetical order.

PATTERN OF HUNGARY'S FOREIGN TRADE WITH MAJOR COUNTRIES

(Percentages)

	Imports	Exports
Total	100.00	100.00
Yugoslavia	4.5	4.3
Argentina	0.9	1.1
Brazil	0.4	0.5

YUGOSLAVIA

	Unit	1949	1955	1958	1959	1960	(Percentage a)
TOTAL IMPORTS							100.0
Iron ore	1000 m tons	112	—	159	19	90	3.9
Sulphate cellulose	m ton	—	—	1692	5490	3601	2.4
Timber (deal)	1000 cu m	31	20	43	31	34	7.2
Decidous timber	1000 cu m	—	—	8	4	10	3.7
Railway sleepers, normal and for points	1000 cu m	—	—	10	12e	12	2.8
Cured tobacco	m ton	—	—	1488	—	682	2.4
Firewood	1000 m tons	46	46	156	122	23	1.4
Loose synthetic fibres	m ton	—	—	597	1496	2333	5.6
Wine in barrels	1000 hl	—	—	68	81	63	2.1
Electric current	mill. Ft	—	—	9	8	11	4.4
Railway loading trucks	pc	—	—	--	399	749	15.0
TOTAL EXPORTS							100.0
Tip cranes	pce	—	—	11	16	13	1.8
Railway passenger cars b)	pc	—	—	40	12	33	3.8
Buses (incl. chassis)	pc	—	4	119	138	75	1.7
Trucks and chassis c)	pc	—	—	754	606	550	6.5
Diesel spare parts for vehicles	mill. Ft	—	—	3	17	15	3.4
Iron raw material for steel production	1000 m tons	—	—	20	20	21	3.3
Laminated steel	1000 m tons	3	4	17	7	8	3.1
Agricultural machines and spare parts	mill. Ft	—	—	22	22	36	8.1
Electric tubes for radio receivers	1000 pcs	3	119	1154	1564	1144	1.0
Nitrate fertilizer	1000 m tons	—	5	8	18	15	1.9
Locks, padlocks, fittings	m ton	5	27	220	204	284	1.2
Cotton fabrics	1000 sq m	—	—	1854	3172	3864	3.5
Electric current meters	1000 pcs	—	—	11	24	34	1.6

a) Rate of the imported and exported goods calculated on the basis of their value data.
b) Including special-purpose railway cars
c) Including dumpers and special-purpose vehicles

INTEGRA DOMINO AUTOMATIZATION SYSTEM

INDUSTRIAL development in every part of the world raises ever higher demands as regards control equipment. The number of points and of appliances to be controlled multiplies at a fantastic rate.

The starting point of up-to-date control systems is their building up of small, interchangeable units. The *integra domino* control system features a considerable number of advantages.

The principal assets of *integra domino* can be summed up as follows :

Extremely wide field of application.

Reduced floor space requirement. Miniaturized building elements.

Building elements readily interchangeable, permitting the easy and quick transformation of the control system.

Maximum possibility of prefabrication, quick setting up. Minimum preparation and assembly work on the site. Ingenious construction, and a wide choice of building elements ensure a versatility which could not have been imgained before.

Integra domino allows easy fitting in with any modern control and automatization system. It will prove highly useful in any field where the indication and/or control of conditions and processes is required. It can be matched to various tele-indicator and remote control gears.

(Continued from page B.14)

ARGENTINA

	Unit	1949	1955	1958	1959	1960	Percentage a)
TOTAL IMPORTS							100.0
Raw cattle hide	1000 m tons	6	6	10	6	11	86.5
Raw fur skin	m ton	287	29	368	362	186	2.6
Tannin extract	tannin/m ton	—	570	2154	240	2398	8.0
TOTAL EXPORTS							100.0
Laminated steel	m ton	1829	—	3445	498	30071	39.2
Motor train spare parts	1000 Ft	—	3651	2836	2951	8063	6.9
Steel aluminium cable	m ton	—	2490	1089	2161	604	3.2
Telephone exchanges	1000 Ft	245	8193	2123	10237 br-13	252 b-	11.4
Incandescent lamps	1000 pcs	—	2970	98	1395	330	0.5

BRAZIL

	Unit	1949	1955	1958	1959	1960	Percentage a)
TOTAL IMPORTS							100.0 a)
Coffee	m ton	29	972	1092	5192	1470	26.8
Cocoa beans	m ton	—	1332	1489	2309	2992	45.9
TOTAL EXPORTS							100.0
Bicycle spare parts	1000 Ft	—	—	657	478	890	1.9
Reaper-thresher combines	pc	—	—	100	266	215	22.0
Steel aluminium cable	m ton	—	—	63	49	252	3.0
Electric current meters	1000 pcs	—	24	65	33	67	6.4
apparatus	pc	—	—	3	5	6	0.8
Chlorocide	kilo	—	—	—	—	427	0.6
Photographic film	1000 sq m	—	—	—	3	8	0.5

a) Rate of the imported and exported goods calculated on the basis of their value data
b) Including value of the spare parts

One of the most important sections of an up-to-date control system is the scheme or operating device. We propose to describe its components and construction first.

The scheme board, operating bench or bench board consists of a quadrate building element incorporating many important advantages as compared to other solutions. One of them is that it can be mounted in four different positions, by being rotated in 90° each time. This makes an important reduction in the number of elements necessary to build up the control system, many variants being made possible by simply rotating the same element.

Domino building element, of a basic area of 40 by 40 mm consists of two parts. The lower part is a pressed bakelite base bearing the contacts, the upper part, a metal die casting holds the control buttons, pilot lamps and optical equipment. The upper part can be lifted out of the scheme with a small permanent magnet, which renders the lamps and the lower part accessible. The lower part is screwed to the frame made of profile iron. Two tongued, spring plates connect between the two parts. This solution has been found preferable because of the quick accessibility of the inside of the element obtained with the permanent magnet mentioned above.

The cover plate of a *domino* element may be of the blind scheme or of the illuminated type (or a combination of the two). In the first case, the scheme is painted or engraved on the cover. Illuminated schemes have inspection windows covered by coloured glass plates.

Monitoring light signals may be of any chosen colour, or, owing to optical colour change, in the same colour-strip, light of another colour may appear. This may be used, for instance, to signal a change in the quality of the part represented by the scheme. Connected and disconnected conditions of electric networks can be represented by different colours. Considering that, in addition to the above, the small monitoring lamps may be lit periodically or aperiodically (blinking, flashing) we can say that the integra domino building element offers a rich gamut of representation with the illuminated scheme type.

Various symbols and figures can be cut and lit on the cover, which permits the keeping in application of the symbolization technique used with the *integra domino* control system.

The actuating organs of modern control techniques are push buttons and rotating switches. *Domino* building element can be equipped with such organs, further to improve their versatility.

Push buttons applied in *domino* building elements are of double action. Fixed contacts, placed in the pressed bakelite lower part, are of the same design as spring lamp contacts. The contact bridge and other parts of the buttons are mounted in the upper part. Push buttons are manufactured with one and with two contact bridges. Thus out of the twelve contacts in a *domino* building element, each button takes either two or four contacts.

Control systems also include push buttons that are operated under particular conditions only (for instance, intervention in automatic operation, emergency stops etc.). Such buttons must be equipped with devices preventing unintentional operation, and where they have been used, this must be traceable in some way. For such purposes *integra domino* has buttons under lead. A scaled locking tongue moving parallelly to the plane of the cover plate enters a groove in the button shank, and can be removed from the groove to release the button for operation only when the lead seal has been removed.

Where buttons that can be fixed in a punched-in condtion are required, *domino* building elements may easily be equipped with such buttons, whose shanks can be turned when the button has been pushed in and fixed the control in its position. It order to release the button again, the shank must be turned back to the original position.

Multifarious tasks arising in control techniques may require the application of rotating cylinder switches. The designers of *domino* building elements have given due attention to this problem, too.

Domino building elements may be equipped with two or three-position, and with four or six-position rotary switches. Two and three-position switches engage half of the element (six contact places), four and six-position switches the whole of it. Thus a building element equipped with a two or three-position switch will have half of the contacts reserved for push buttons or monitoring signals. Every switch has a set of working contacts corresponding to the number of its positions.

One part, often important, of the scheme is composed of blank spaces, containing neither monitoring signal nor operating organ. Such spaces can be filled with blank *domino* building elements, which, of course, have the same dimensions as other *domino* elements.

Integra domino building elements are generally used to build up benchboards or scheme boards. By the lower, pressed bakelite parts, the elements are mounted in angle iron frames and fastened with screws.

Integra domino building elements can be mounted in any position from the horizontal to the vertical. *Integra domino* schemes can take up the whole surface of a bench board or may be mounted on a smaller, slanting superposed panel. With schemes of smaller size the latter solution is usually preferred. The bench board can be shaped as a writing desk and made of any suitable material. The bench board can also carry telecommunication apparatus and other devices used in the control of the enterprise. With independent schemes formed of *domino* building elements, the scheme board may be of small size, composed of a few elements, or may be built up of several thousand elements, mounted in a self-supporting steel frame. In the first case a well-proved device is to hang the scheme on the wall like a picture. In the second, a buried construction is preferable. Naturally the wall enclosing the space around the scheme will not form a single load carrying unit with the scheme, the latter being only pushed into the recess.

In connection with *domino* control system and scheme boards let us say a few words about accessory equipment.

Every *domino* control has a permanent magnet used to lift out the upper parts of the elements. In addition, the schemes generally are completed with a built-in lamp testing device which permits the checking of bulbs before they are put into use.

There often occurs the necessity of placing some warning on the board, for instance "Not to be switched on", or to cover one or another of the buttons in order to prevent their unintentioned operation at the respective scheme part or at the master control. This may be obtained through small magnetic caps to be put on the respective buttons. The caps can be provided with any desired symbol or inscription.

The luminous intensity of illuminated schemes needs adjustment according to the light conditions, of the surroundings. In day time the same light effect requires a much higher luminous intensity than at night.

News from the Hungarian Industry

The largest completed investment in 1961 was the reconstruction of the forging plant of the Ganz-Mavag Machine and Waggon Factory which employs 15,000 workers. Now the forging plant has a modern 3,000 ton press and a full-width crane.

At Szombathely, the building of one of the plants of the Remix factory has been partly finished. This plant manufactures capacitors, fixed capacitors and resistors for wireless sets. Although the plant is operating with a staff of 750, the enlargement programme is still going on. In a village, near Veszprem a radio-cabinet manufacturing plant has been established. It already employs more than 1,000 workers. At Bugyi, in Pest County, a telephone and portable radio factory has been set up.

Our report about new products also covers medical and health instruments. A new, up-to-date narcotizing apparatus has been developed and has gone into bulk production. Universal inhalators are also being made in serial production. The precision Wheatstone-Thompson bridge, the four-channel electro-encephalograph, the five-channel electrocardiograph, the electromanometer, the pulsatotachometer, will soon be on the market.

Machinery to Produce Seamless Tubes

ECONOMIC advantages and a high degree of dimensional versatility have been the two main factors behind the rapid spread of the push-bench system of producing seamless tubes. This is particularly true in the smaller diameter range. Tubes of from 66 to 136 mm. diameter can be produced on the push-bench.

The electric motor, through a double-helical gear drive, transmits power to the push bar. In front of this bar operating mandrel is placed by the feeding mechanism and pushed by the bar into the pierced glowing ingot. The mandrel on its forward path with the glowing ingot, proceeds with great force through rollers, where they take on their tube shape. Smaller diameter tubes are processed by subsequent narrowing in the reducing mills.

Drive is supplied by an electric motor. Rotary movement is transmitted through connecting rods to the water-cooled rollers. The tubes, passing between gradually decreasing clearances, assume the requisite dimensions.

The Pilger system of tube manufacture requires considerable power which is supplied by carefully coupled and tested direct-current motors. To ensure maximum operational safety, great care is devoted to the outstanding quality of materials of the motors.

The tube mill is controlled by means of a control equipment, designed to withstand tropical weather conditions. The insulation will stand up to very high temperatures. The control panel is easy to survey and its component parts are readily accessible.

High-voltage a.c. is converted into d.c. current by means of an up-to-date mercury-vapour rectifier. The speed of the 2000 kW d.c. motor is variable and the unit in normal operation can withstand momentary shocklike overloads.

Although starting is effected by a signal given by the attendant, the putting into operation proper takes place in the control room where on the instrument panel, loads can be continuously supervised.

Electric motor driven pumps operate in the hydraulic machine room, to supply water for the actuation of the machines, at 206 atmosphere pressure.

Pressure differences are balanced by the up-to-date storage batteries which have pressure resistant winding. Air at 15 atmospheres is supplied by compressors.

This machine, on which the first phase of tube manufacture according to the Pilger process is carried out, applies at least 1800 tons pressure in forcing the piercing mandrel into the glowing ingot. The pierced ingot is then passed for further machining to the elongator, whose heavy rolls are electrically driven. Between the rolls of this machine the pierced ingot assumes uniform wall thickness and in the course of elongation becomes suitable for Pilgering.

The thick-walled raw tube reaches the feeding equipment for further machining. An incorporated lifting device places the pierced and elongated ingot on to the new mandrel. While the mandrel is operated by compressed air, the slide is hydraulically actuated.

The next procedure is the rolling of the tube between rolls of special material and shape; these are the Pilger rolls. These too, are driven by a motor, of 2,000 kW output.

Shocks in load are balanced by a series of flywheels while in the appropriately geared driving mechanism double helical gears ensure good coupling and noiseless running. Power is further transmitted to the rotary stand through a geared clutch, whence rotary motion is passed through articulated rods to the Pilger rolls. The rolls are adjusted by means of electric motors. The clearances between the rolls can be accurately set by means of an indicator.

Accurate exterior diameter of the tube product is ensured by a sizing mill, viz. pairs of rolls rotating in opposite directions. It constitutes part of the five stand machine. Depending on the required dimensions of the tube, the rolls are interchangeable, and for higher accuracy of dimensions adequate pressure is applied to the tube as it passes between the rolls.

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