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JOURNAL OF INDUSTRIAL ENGINEERING

CONTENTS

FLAME HARDENING

THROUGHOUT the ages, heat has been the servant of mankind. We find it working for us in the giant blast furnaces, in mighty Locomotives, in driving the Wheels of Industry, and, later, in hardening the steel to the proper degree.

The use of heat in the hardening of steel goes back many hundreds of years. While industry was developing its mass production machinery and methods as we know them to-day, heat-treating kept in step with new processes and equipment designed to overcome the problems of uniform heat penetration, of scaling, of distortion and of accurate temperature control.

Flame hardening by using Oxy-acetylene flames, while considered one of the new-comers in the field of heat treating, was invented by A. E. Shorter and the method was more or less used at that time as a medium for localized heat treating to produce case hardened surfaces. The process consisted of locally heating parts by an Oxy-acetylene or other oxy-fuel blow pipe, swifty followed by water or other type quenching through specially designed water jets It was customary in those days to judge the time for quenching by the colour of the piece, a method which to say the least, did not bring consistently uniform results on piece after piece.

From that day to this, however, the untiring efforts of engineers and designers to better control this useful tool has resulted in much progress, and to-day flame hardening has taken its place in high production lines. The obvious advantages associated with this process are that it gives localised heating with virtually no distortion, it requires low capital, running and maintenance costs are low and being flexible it is both suitable and economical for large or small production. Other advantages are: (a) high degree of surface hardness given; (b) Core remains unchanged; (c) Core may be heat treated for toughness and ductility first, and hardcase produced afterwards without any reduction in the strength of the core; (d) case merges gradually into core, and hardness persists over about 80 per cent of the hardened area's depth.

While in case of ordinary case hardening, the composition of steel is changed, the same is not the case with flame hardening. Steels for flame hardening range from 0.3 — 0.6 per cent carbon, but medium carbon alloy steels may also be hardened. Molybdenum is a valuable element in alloy steels for flame hardening.

The field of this flame hardening has further been broadened by the development of Flamatic Hardening Machines which are equipped with electronic temperature control system. Since the actual temperature of the work piece is the governing factor, both surface hardness and depth of heat penetration are controlled within narrow limits. A highly sensitive thermopile is focussed to receive radiant energy from the work as it rotates during the heating cycle. A temperature recording and controlling instrument

receives the E. M. F. generated thereby. As soon as the work piece reaches the pre-determined temperature, the thermopile causes the entire electronic control system to go into action whereby the flames are extinguished, the work stops rotating and the spindle is retracted to allow the work piece to be quenched. Close and accurate control of surface temperature results in the uniform depth of heat penetration without any distortion.

Production rates are high with these machines, since a complete cycle of the machine often is a matter of seconds. The cycle is fully automatic except for loading, which makes for economical operation, since no particular skill is required for the operator.

Quick set-ups on the Flame hardening machine make it possible to provide emergency service which customers sometimes demand. It is also possible to estimate the cost factors of Flamatic hardening closely. Since the burners operate only during the pre-determined heating cycle, gas consumption is kept to a minimum. Except for loading, the cycle is fully automatic and no particular skill or long training period is required for operation. The item of rejects, an important factor in customer satisfaction, is reduced to a minimum because the electronic control assures accurate temperatures within plus or minus 5 degree F., and in addition, the oil quench eliminates the troublesome element of distortion and craking.

Further development of the method is characterised by the application of natural gas as a fuel on the Flamatic machine instead of acetylene or propane. This means a further reduction in the cost of work piece as the cost of natural gas is much less than that of propane or acetylene.

The flame hardening has been successfully applied to aircraft and automobile industries. Other industries can equally take advantage of it. Typical among the jobs which are flame hardened are : Worm shafts, spur gears, cluster gears, clutch rings, brake drums, cams, straightening and bending rolls, crankshafts, journals etc.

Day after day, engineers are making additional applications which demonstrate the flexibility of the process and which give further proof of its practicability for the wide variety of work.

Indian industry has before it a great potential of engineering developments, new methods, and new tools with which to maintain and improve high levels of consumer buying, of general business activity of gross national production, income and employment. To successfully meet the situation and also to lay a foundation for a sound future, full advantage should be taken of the great wealth of new ideas and methods which have been developed through research in engineering. When this is done it will result in increased productivity which will keep our national economy strong and insure our national security —in fact, our very existence.

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INDIA'S MANGANESE---New orientation in its exploitation necessary

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and S. Gopal,*** B.Sc.

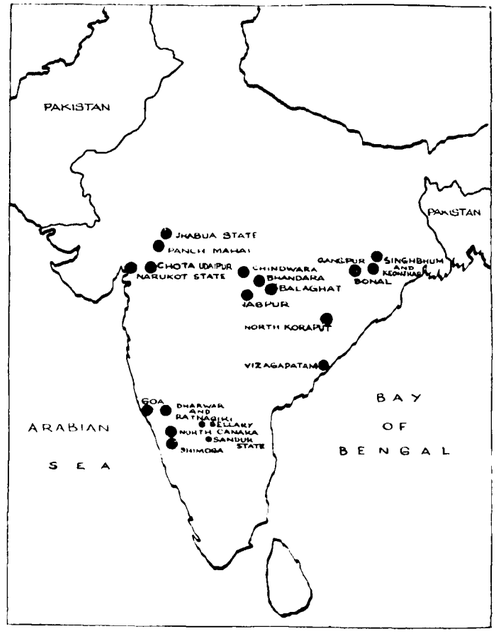
"The Wealth of India"—What a vision of past history and splendour it brings, when the Indies attracted adventurers in search of wealth and fortune from the most distant countries! Yet all the world knows that India is full of poverty-stricken people to-day. Nevertheless, India is wealthy and the wealth of India is there. But in spite of this wealth, the people are poor. **The problem for us is to utilize this stored-up wealth of the country in the soil and under the soil, for the benefit of Indian humanity.**

.... Jawaharlal Nehru[1]

THOUGH manganese was discovered by Johann Gottlieb Gahn and Scheele as early as 1774, its importance was realised only as late as 1880 when its usefulness in steels was established; and since then demand for manganese was growing year after year.

Although manganese deposits are widely distributed throughout the world, commercial production is confined to only a few countries, namely, Russia, India, The Gold Coast, Brazil and South Africa, which together contribute about 82% of the world's annual output. Among the countries mentioned above, *India holds a unique position, second only to the U. S. S. R., in respect of manganese ore resources*; and yet it is countries such as the U. S. A., Germany, Britain, France and Japan, which have always had to depend largely upon other countries for supplies of manganese ore, that stand to-day as the leading steel producers in the world. Between them these countries together account for about 70% of the world's annual steel output, excluding that of U. S. S. R.

More than 90% of the manganese ore raised in the world goes into the metallurgical industries, chiefly for the manufacture of ordinary carbon steels, special high-manganese steels etc. It is said that "steel is not steel unless it contains an appreciable percentage of manganese". It may be recalled that special manganese steels, containing about 11—14% Mn are very hard and



MANGANESE ORE LOCALITIES IN INDIA
after J. A. DUNN

Fig. 1

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** Junior Scientific Officer, do. do.
*** Senior Laboratory Assistant, do. do.

1 The Wealth of India, Vol. I, 1948 (C. S. I. R., Delhi), 'Foreword' by Jawaharlal Nehru.

exceedingly tough. They are noted for their resistance to both abrasion and shock so much so that they provide a unique material for making rock-breaking machinery, including geologists' hammers, as aptly pointed out by J. A. Dunn, one-time Superintending Geologist, Geological Survey of India!

A few other significant uses for the ore, depending upon the particular grade and type, may perhaps be mentioned in this context.

The chemical grade ore is used as depolariser in dry cells.

In the glass industry high-grade ore is used as decoloriser when iron is present in the melt.

Manganese dioxide is used as pigment in ceramic glazes and enamels.

It also finds uses in the chemical industry, viz., the sulphate, the chloride and the permanganates.

The first manganese deposits which were worked in India were those near Kodur, Vizagpatnam district, in the year 1892. Since then deposits in various other localities in the country came to be extensively exploited for overseas' markets. The ore-deposits are more or less widely distributed in Bihar, Orissa, Madhya Pradesh, Andhra Pradesh, Mysore, Bombay and Rajasthan, as shown in the map (Fig. I).[2]

For over the last fifty years private enterprise has been exploiting the manganese mines, but only for purposes of export. An idea of the annual exports could be had from the figures presented in Table I.

TABLE I

Manganese-ore exports from India

Year	Tons (approx.)	Value in Rupees (approx.)
1937	10,01,000	21,29,000
1938	4,56,000	1,07,25,000
1939	7,19,000	1,82,74,000
1940	5,10,000	1,47,43,000
1941	7,22,000	2,46,32,000
1942	5,77,000	1,90,62,000
1943	5,49,000	1,84,78,000
1944	1,57,000	53,35,000
1945	1,85,000	65,34,000
1946	4,62,000	1,84,14,000
1947	5,21,000	2,48,64,000
1948	3,09,000	1,81,00,000
1949	—	—
1950	9,00,000	—
1951	12,90,000	—
1952	—	22,00,00,000
1953	—	23,00,00,000

The U. K., Canada, Sweden, Norway, Denmark, West Germany, Netherlands, Belgium, Spain, Italy, Austria, Yugoslavia, Japan, U. S. A., Hong Kong and Burma are amongst some of the more important countries regularly importing the Indian ore. In the year 1953, for instance, the U. S. A., the U. K., West Germany and Japan shared the exports from India as given below:

Manganese ore exports	to	U. S. A.	.. .. ..	worth Rs. 17,38,00,000	(approx.)
do.	do.	to U. K.	.. .. ..	worth Rs. 2,73,00,000	(approx.)
do.	do.	to West Germany	.. .. ..	worth Rs. 1,39,00,000	(approx.)
do.	do.	to Japan	.. .. ..	worth Rs. 1,38,00,000	(approx.)

From the facts presented above it could be gathered that what position and status the Indian manganese mining industry has attained to-date has been almost entirely on account of its almost unrivalled export-potentiality.

The continued demand for high-grade manganese ores (45% Mn and above) has resulted in the establishment of a *tradition* in the mining circles to select only that grade of ore which fetches good prices in the foreign markets. The cumulative effect of such a selective export policy has been the *accumulation* of hundreds of thousands of tons of the so-called inferior-grade material at various mining centres in the country. This low-grade material, though industrially useful, is relegated to huge dumps, altogether neglected. The low-grade material lying in dumps in Madhya Pradesh is estimated to be of the order of 37 lakh tons, in Andhra Pradesh about 12 lakh tons, and in Bihar and Orissa about 2 lakh tons.[3] It is interesting to note that large quantities of this material were even used as "Road-metal" in Madhya Pradesh![4]

Of late a number of factors, notably

[2] J. A. Dunn, Records of the Geological Survey of India, Vol. LXXVI, No. 9, 1942, PP. 47.
[3] "The Hindustan Times", November 2, 1953. PP. 3.
[4] Malhotra, S.S., Indian Min. Industr. J., **2**, (1952), 7.

(a) the stock-piling of adequate quantities, in the U. S. A., and other countries,

(b) the resumption of exports by the U. S. S. R. and thus her re-entry into the competitive market,

(c) the policy of self-sufficiency at any cost lately emphasised in the U. S. A., and

(d) the recent opening out of the Brazilian mines[5] even in the face of very great difficulties and high costs,

have resulted in a steep fall in overseas' demands, thus leading to a "near-crisis" in our manganese industry. *It seems that mines producing the second and third grade ores, may have to practically close down, under the circumstances.*

In the face of such a situation, *it is evident that a new orientation in policy becomes imperative*, if Manganese mining operations are to continue with profit to the operators and benefit to the country's economy. The old policy of mining for exports only, pursued for well over half-a-century, has to be revised. For independent India evolving plans of brisk and far-reaching industrialisation, *it is not the right course to continue forever playing the role of supplier of raw materials (minerals) and purchaser of finished products and manufactured goods.* It is not a happy situation for the Manganese Mining interests themselves to be looking forward constantly and anxiously to every passing trend in the fluctuating world-markets. Indigenous production, at least to the extent of self-sufficiency, has to be aimed at in the various industries as much as possible, even if it were to be found a little more costly, to begin with. *With this end in view a few suggestions comprising some kind of a fresh orientation in the exploitation of Indian Manganese are put forth in the following pages.*

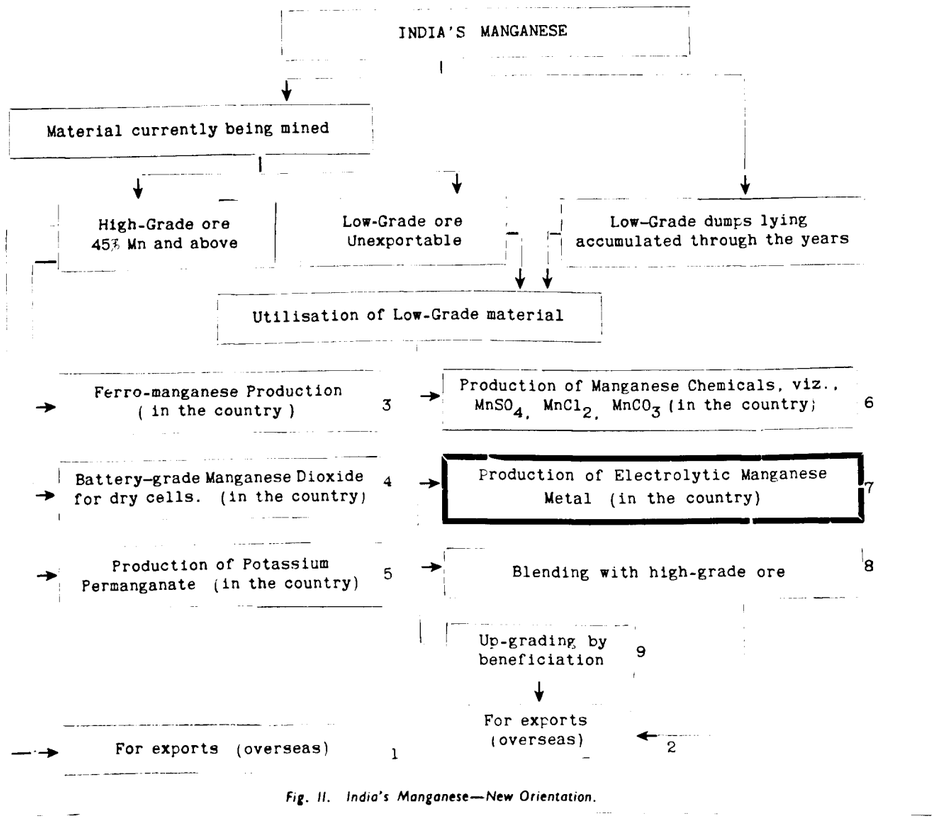

Fig. II. India's Manganese—New Orientation.

HIGH-GRADE ORE

From 1 and 2 of Fig. II it is seen that high grade ore (45% Mn and above) can be produced

(a) directly from certain mines,

(b) by blending suitable low-grade material with rich ore available at selected localities,

and (c) by beneficiating low-grade ores.

(a) and (b) are already current practice. (c) is in the pilot-plant stage of development in our country.

High grade material thus produced (1 and 2 of Fig. II) is fit both for overseas exports and for meeting the indigenous demands in the country for the production of Ferro-Manganese (3 of Fig. 11), for battery-grade Manganese dioxide for dry cells (4 of Fig. 11) after suitable treatment, and for Potassium permanganate (5 of Fig. II). In fixing the export-quotas from year to year, it is obvious that due care has to be taken to earmark adequate quantities for internal needs in the country.

LOW-GRADE ORE

As stated earlier millions of tons of low-grade ore are available *both* from the mines currently in operation and from the huge dumps of rejects lying accumulated through the years at various mining centres. Utilisation of the low-grade material has always remained a big problem and the solution of this problem is bound to be of keen interest to the Indian Manganese Industry.

Production of Manganese chemicals, viz., Manganese Sulphate, Manganese Chloride and Manganese Carbonate (6 of Fig. II) has great possibilities. *Besides the numerous applications of these chemicals for different purposes in the country, there are also extensive export-possibilities for these chemicals. For more reasons than one it is advisable to ship these chemicals rather than the raw ore.*

Production of electrolytic Manganese metal, 99.9+% purity, (7 of Fig. II) is also going to be a very important development in the years to come. *This valuable virgin metal is already finding increasing uses in the production of a variety of special-purpose Manganese-base and high-Manganese alloys in the U. S. A., Japan, the U. S. S. R., and other countries* (Table II). Chromium-Nickel-Manganese austenitic stainless steels

TABLE II

Some known uses of Electrolytic Manganese alloys

Sl. No.	Name of the alloy	Composition	Property	Uses
1.	High-vibration damping capacity alloy	80% Mn, 20% Cu	Relative insensitivity to cold work	Used for noiseless gears and machine parts; as a cam material for textile machinery; and for plates of electrical condensers
2.	Brazing alloy	85% Cu, 15% Mn	—	As a brazing alloy for hollow propellers
3.	High-expansion alloy	72% Mn, 18% Cu, 10% Ni	Unusually high co-efficient of expansion and high electrical resistivity; high elastic limit and heat conductivity	For thermo-static bimetals; in the form of tubes for heat control apparatus; useful for shafting where heat transmission is undesirable
4.	Age-hardening alloy	(a) 70% Cu, 15% Mn, 15% Ni	Maximum hardness but yet sufficient ductility	Jewellery industry; for watch cases, clip, pen and pencil barrel and spectacle frames
		(b) 60% Cu, 20% Mn, 20% Ni	—	For springs and diaphragms; for Bourdon tube and similar purposes; extensively used for watch and instrument parts.
5.	Coinage alloy	(a) 67% Cu, 18% Mn, 15% Zn	—	These alloys can be used as suitable substitutes for cartridge brass, cupro-nickel and various grades of nickel-silver alloys. These can also be used as coinage alloys in India as there is no nickel in India.
		(b) 50% Cu, 35% Mn, 15% Zn	—	
		(c) 35% Cu, 50% Mn, 15% Zn	—	
		(d) 40% Cu, 50% Mn, 10% Ni	—	
6.	Electrical resistance alloy	65% Cu, 30% Mn, 5% Al	—	Used for electrical resistances
7.	American 5-cent coin during World War II	36% Ag, 9% Mn, 55% Cu	—	Similar to 75% Cu, 25% Ni alloy
8.	In stainless steels			As a substitute for nickel in general

have recently been developed, especially "types 201 and 202 for example, which have properties which make them equivalent to types 301 and 302 in many applications where these Chromium-Nickel stainless steels formerly have been considered virtually irreplaceable". It is even stated that the new low-nickel high-manganese steels have better properties than the older materials and that they may be used to advantage in many applications where the 18—8 types are now employed. *The importance of these developments can hardly be over-emphasised, especially for India which suffers from a total deficiency in Nickel resources while she has abundant resources of Manganese.*

In what follows two important products namely Manganese Sulphate and electrolytic Manganese metal are described in some detail, since their methods of preparation have been satisfactorily worked out on a "large-laboratory scale" in our country in recent years, so much so, that tonnage-production may straight away be taken up by those connected with Indian Manganese Industry.

MANGANESE SULPHATE

Manganese Sulphate finds extensive uses in other countries:

(a) *as an addition to fertilisers to correct manganese —deficiency in the soil*; spectacular results are achieved in point of yields especially in vines, tobacco and tomato cultivation,

(b) as an essential ingredient in live-stock feeds, especially chicken-feed,

(c) in textile dyeing and calico-printing,

(d) in the formulation of æroplane-dopes,

(e) *for making manganese driers for the paints' industry*,

(f) for the manufacture of hige-purity electrolytic manganese metal itself,

(g) *as a crystalliser in salt-manufacture*: (it is known that addition of manganese sulphate increases the yield of salt by 10—15%; the crystals are large and hard and resemble weathered salt in dryness and they are in big clusters.)

The demand for manganese sulphate in the foreign markets, especially in the continental markets, appears to be very great. In the U. S. A. alone about 20,000 tons of manganese sulphate go into fertiliser-combinations every year.

Work on the production of manganese sulphate, which was taken up at the Central Electro-Chemical Research Institute, Karaikudi, in response to technical enquiries from Indian firms has been completed and the products have been found to satisfy the required specifications as regards purity and freedom from insoluble matter. *A non-technical note (N. T. N.) detailing the relevant information including cost-data can be had from the National Research Development Corporation of C. S. I. R., New Delhi*, by anyone interested in setting up indigenous production.

It may not be out of place to mention in this context that the production of manganese chloride is also a worth-while proposition in our country, in that it partly solves the vexing "chlorine-disposal problem" which our electrolytic alkali industry currently faces. Manganese chloride has a number of uses:

(a) in paper manufacture,

(b) in the dry cells' industry,

(c) as a flux in refining metallic magnesium and alloys,

(d) as a catalyst in chlorination of organic compounds,

(e) in the formulation of æroplane-dopes,

(f) for making manganese driers, largely required in paints' industry.

HIGH-PURITY MANGANESE METAL (ELECTROLYTIC)

For more than 40 years research workers in the metallurgical field have been trying to produce electrolytic manganese metal of 99.9+% purity by electro-deposition from aqueous solutions of Manganese and Ammonium Sulphates or Chlorides. The metal which is being produced by the other methods, e. g., Aluminium Thermite process, is at best of only 98% to 99% purity which cannot be put to the distinctive uses such as for the production of new special-purpose alloys, which are coming to the fore in recent years and for which 99.9+% pure manganese metal alone will serve the purpose.

During World War II due to the uncertainty of Manganese ore imports into U. S. A. the production of electrolytic manganese metal was conceived as a part of National Defence Programme. This work was taken up in 1935 by the Bureau of Mines, metallurgical division, under the direction of R. S Dean, and the first pilot-plant went into operation in 1939 producing about 2000 lbs. per day.

Based on the successful results obtained on the above pilot-plant, further work on this was taken up by a private company, Electromanganese Corporation, and its plants at Knoxvillee, Tennessee, reached a production figure of 4½ million pounds in the year 1948.[6] In order to meet the increasing demand year after year that company gradually stepped up production. By January 1951 these plants were producing over 10 short tons per day. Late in 1953 another 10-ton per day plant also went into production.[7] On the whole the Electromanganese Corporation alone to-day produces about 20 tons of Electrolytic manganese metal per day. Besides, in view of the world shortage of Nickel and in view of the possibilities of substituting nickel by electrolytic manganese in stainless and alloy steels, and in order to thus conserve nickel for other purposes, Union

[6] Engg. Min. J., Vol. 150, No. 7, 1949 PP. 128.

[7] Harry A. Curtis, J. Electrochem Soc., Vol. 101, No. 5, 1955. PP. 119C–127C.

Carbide & Carbon Company's Electro-metallurgical division, by name Electrometallurgical Company, recently installed another electrolytic manganese plant at Marietta, Ohio, which, when in full operation, will be producing at the rate of a further 20 tons per day, which means about 6,000 tons additional production per year."

The production of electrolytic manganese metal in the U. S. A. thus appears to be of the order of over 12,000 tons annually. As a matter of fact, according to Mantell, the figure has reached 15,000 tons per year.

It is learnt that about 60 to 70% of this production goes into the manufacture of stainless steel and alloy steels.

Besides U. S. A., other countries like Russia, Germany, Italy, Canada and Japan are also known to be producing electrolytic manganese, though exact figures are not available.

Japan's production for the last two years seems to be as follows:*

1955——688 tons
1956——672 tons (April—September)
1956——130 tons (October)

As regards the applications of electrolytic manganese metal in the metallurgical industry, it may be worthwhile quoting at length from Mantell[10]:—

"Electrolytic manganese is a growing industry and over 20 million pounds have been produced and consumed. During the war period, appreciable quantities were furnished for military needs and those of our Allies, as well as to the U. S. Mint for the coinage alloy of the 5-cent piece when nickel was displaced in coinage.

"High purity (99.9+%) electromanganese, made by the electrolytic process, has firmly established its advantages by wide use over a number of years. Absence of impurities has given the non-ferrous and ferrous metallurgists an alloying element which not only secures uniform results, but also in many instances has produced improved mechanical properties. Manganese metal of this purity has further made possible the development of a number of new high-manganese alloys, as well as an entirely new field of manganese-base alloys.

"Manganese is an important constituent in alloys of aluminium, copper, iron, magnesium, and zinc, as well as more complete systems involving these metals. Manganese additions to brasses, bronzes, and nickel silvers have received considerable attention. Manganese finds applications as a scavenger, deoxidizer, and degasifier in specialty alloys for high-temperature service as those of nickel-chromium and nickel-chromium-iron, in strip steels, and a wide veriety of stainless steels and irons of the manganese-chromium-iron, the manganese-chromium-nickel-iron, and other alloys. Manganese enters the field of powder metallurgy as a constituent of contacts, preformed catalysts, and sintered alloys. Its pure form makes it an ideal starting point for special chemicals of high purity."

Allegheny Ludlum Steel Corporation,[11] Pennsylvania, has recently standardised the "chromium-nickel-manganese austenitic stainless steels" using electrolytic manganese (Table III). And these alloys are found to be almost similar to those of the conventional 18—8 stainless steels of the type 301 and 302. Fuller data about the composition and important properties of a number of stainless steels containing electrolytic manganese, as part-replacement of nickel are given in one of their technical bulletins.

As regards the price of electrolytic manganese metal, it is claimed in the U. S. Steel production circles that the advantages gained by the use of pure electrolytic manganese more than compensate for the greater cost of the material. (The price is expected to fall considerably with the expansion of manganese production).

In India the production of electrolytic manganese from indigenous pyrolusite ores received for the first time some attention in 1943, when the Board of Scientific and Industrial Research, New Delhi assigned a scheme of work to Messrs. The Indian Standard Metal Company Limited, Bombay. One of the authors* was associated with that research project. After successful production on a pilot-plant scale † the work was stopped since the formulation and application of several special purpose manganese alloys in those years were very limited, and the Indian Metal Industry

* J. of Metals, Vol. 7, No. 1, 1955. PP. 10–11.

* Prof. Sakæ Tajima, Laboratory of Electrochemistry, Tokyo Metropolitan University, Tokyo–personal communication.

[10] Mantell, C. L., Trans. Electrochem. Soc., Vol. 94, No. 5, 1948. PP. 232-243.

[11] Allegheny Ludlum Steel Corporation, Pittsburgh 22, Pennsylvania, "Allegheny Ludlum Technical Studies," Number 3.

* Y. D. Prasada Rao, J. Sci. Industr. Res., 6B, 1947), 37–42.

† Dr. A. N. Ghosh (at present Joint Director, Indian Standards Institution, New Delhi), was in-charge of the pilot-plant work at the Indian Standard Metal Co., Ltd., Bombay.

TABLE III

*Some properties of Cr-Ni-Mn austenitic Stainless Steels.**

Property	Type No. and Designation CM (Allegheny)	201 (Allegheny) 17-4-6.	202 (Allegheny) 18-5-8.	301 (Standard) 18-8.	302 (Standard) 18-8.	Remarks.
1. *Physical Properties :*						
(a) Density, lb. per cu. in.	0.28	0.28	0.28	—	0.29	
(b) Thermal Conductivity (Approx.) Btu/ft²/hr °F ft at 212 F.	9. 4	9. 4	9. 4	—	9. 4	
(c) Mean Co-efficient of Thermal expansion, per °F X 10-⁶						These apply to annealed condition only.
68 to 212 F	8. 8	9. 2	9. 2	—	9. 2	
68 to 1000 F	10. 8	10. 9	10. 9	—	10. 2	
(d) Electrical Resistivity, Microhm-cm (Room Temp.)	69	69	69	—	72	
(e) Magnetic Permiability at 200 H	1.02 max.	1.02 max.	1.02 max.	—	1.02 max.	
2. *Mechanical Properties :*						Typically annealed mech. properties.
(a) Yield Strength, 0.2% offset, psi	50,000	50,000	50,000	35,000	35,000	
(b) Tensile Strength, psi	100,000	115,000	100,000	110,000	90,000	
(c) Elongation, % in 2 in.	50	60	60	60	50	
(d) Hardness, Rockwell B	90	92	90	85	85	
3. *Impact Properties :* Izod-impact-ft. lbs. (Room Temp.)	120	120	120	87	120	(Annealed conditions)
4. *Corrosion Resistance :* Corrosion rate in boiling 65% HNO_3 (inches penetration per month)	0.005	0.002	0.002	—	0.0015	(Annealed conditions)
5. *Welding Characteristics :*	(Equally good in all cases and for all conventional methods.)					

Note : "The Cr-Ni-Mn steels have excellent resistance to atmospheric corrosion. For example, in railroad car and truck trailor sheathing and structural members where widely varying conditions are encountered, these materials have given entirely satisfactory service over a period of years. In laboratory salt spray tests, they show less resistance to the formation of rust spots than 18-8, but exposure tests of over three years' duration in a corrosive industrial atmosphere have not produced any rusting or pitting. Stress corrosion tests, made in boiling 42% magnesium chloride solution, indicate that these compositions are susceptible to stress corrosion cracking to about the same degree as the Cr-Ni austenitic steels."

"CM and the 200 types can be welded by all the conventional methods applied to the 18% Cr-8% Ni stainless steels. Shielded arc methods with or without filler metal, arc welding with coated electrodes, and spot-welding produce sound welds with excellent mechanical properties with annealing. Weld ductility is good. The filler wire or electrodes can be conventional Cr-Ni analyses, coated rods and wires to produce welds with the same composition as the base metal have also been developed."

"In most applications where these materials have been used, bending, forming and drawing operations have been carried out successfuly using the same die and tool set-ups as for the corresponding Cr-Ni grades. The deep drawing properties are excellent. Although 202 is somewhat harder than 302 initially, because of the high ductility of 202."

"Annealing and pickling practices used for the Cr-Ni series may also be applied to Types 201 and 202."

"Types 201 and 202 are suitable for virtually the whole range of applications where 301 and 302 have been used successfully, some of the more common uses where the Cr-Ni-Mn steels have proved to be acceptable are decorative and architectural parts, sinks, cooking utensils and hospital ware, dairy equipment, cabinet tops, tubing, high-strength structural members, siding and roofing for railway cars and trailers, etc."

* Acknowledgment of authors to Allegheny Ludlum Steel Corporation, Pittsburgh 22, Pennsylvania, is hereby recorded for the data presented in this table which are culled from Allegheny Ludlum Technical Studies, No. 3, published in 1956.

was not in full apprisal of the potentialities of high-purity manganese as an ideal material which could go into alloy-steels production. Interesting work on the beneficiation of low-grade ore and on production of electrolytic manganese has also been reported from the National Metallurgical Laboratory, Jamshedpur[12].

When the Central Electro-Chemical Research Institute laboratories, at Karaikudi were opened in the year 1953, investigations on the utilisation of low-grade indigenous ores were taken on hand. When the experiments were successfully completed on a laboratory scale of 3 lbs. of metal per day, a larger electrolytic cell unit capable of producing 10 lbs. per day, using 300—350 amps. of current for the electrolysis itself, was set up and was in successful operation for some time.[13], [14], [15], [16], [17]

Fig. III. Large-scale laboratory unit for the production of electrolytic manganese from sulphate baths.

The process developed at Central Electro-Chemical Research Institute, Karaikudi may be summarised as follows, after American practice :

The ore is crushed and ground to-60 mesh, mixed with a suitable reducing agent, namely charcoal or coke, and given a reducing roast

The cooled calcine is dissolved in the spent anolyte overflow (from the electrolytic cells) containing manganese sulphate, ammonium sulphate and sulphuric acid. The impurities in the pregnant leach liquor are removed in two stages.

The purified solution serves as the feed which is fed into the catholyte compartment of a three-compartment diaphragm cell. The feed solution gets depleted of its manganese content in the catholyte chamber, flows into the anolyte chamber, gets enriched in Sulphuric acid content, and finally goes back to the leaching tanks, through the anolyte overflow, to dissolve fresh batches of reduced manganese ores. Electrolytic manganese metal of 99.9+% Mn is thus produced, using the sulphate-bath electrolysis.

It has since been felt however, that, as India has to depend on sulphur imports for the manufacture of sulphuric acid which is required for the sulphate bath, it might be worth-while avoiding the use of sulphate bath, if possible. The alternative chloride bath electrolysis has therefore been taken up for investigations. It may be mentioned in passing, that chlorine is available in surplus from the Electrolytic Caustic Soda Industry of India, to such an extent that the disposal of chlorine assumes the proportions of a serious problem confronting the electrolytic caustic soda industry.

Besides, if chloride bath could be found as satisfactory as sulphate bath, it would be a definite advantage to locate the electrolytic manganese plants in the proximity of alkali-chlorine industry and manganese mines, as is now being contemplated by one of the States' Governments.

Literature studies also indicate that the chloride bath has certain operational advantages.

Considering all the above aspects intensive work on the "production of electrolytic manganese from low-grade indigenous ores using chloride bath electrolysis" has been carried out for over a year at the Central

12 T. Banerjee and B. L. Sen, Indian Patent No. 48499 (1952).
T. Banerjee, H. K. Chakrabarti and N. Dhananjayan, Indian Patent No. 49355 (1953).
T. Banerjee, J. Sci. Industr. Res., 12A, (1953), 457-461.
P. K. Gupta, G. P. Contractor and B. R. Nijhawan, J. Sci. Industr. Res., 12A, (1953), 230-233.
N. Dhananjayan, H. K. Chakrabarti and T. Banerjee, J. Sci. Industr. Res., 13B, (1954), 136-143.
13 A. Joga Rao and Y. D. Prasada Rao, J. Sci. Industr. Res., Vol. 13B, No. 5, 1954. PP. 383-384.
14 A. Joga Rao and Y. D. Prasada Rao, Current Science, Vol. 23, No. 8, 1954. PP. 260-261.
15 A. Joga Rao, Y. D. Prasada Rao and S. Gopal, J. Sci. Industr. Res., Vol. 14B, No. 9, 1955. PP. 467-472.
16 Mentioned by Hon'ble Mr. Nityanand Kanungo, Minister for Industries. (Ref: The Sunday Standard—February 19, 1956).
17 Second Five-Year Plan (Planning Commission, Government of India) 1956. PP. 525.

Electro-Chemical Research Institute. The results obtained have been found to be quite satisfactory.

Using the above experience, a large-scale electrolytic cell unit, taking 300—350 amperes of current and capable of producing about 10 lbs. per day of manganese metal is being set up in the Central Electro-Chemical Research Institute laboratories at Karaikudi.

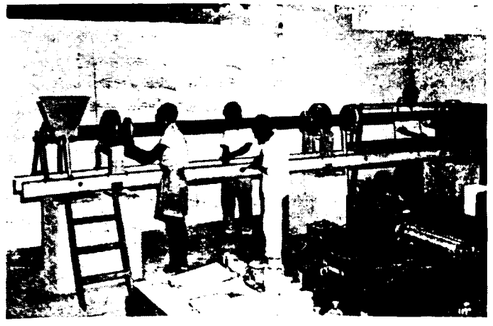

Fig. IV. Roast-reduction Rotary-tube Furnace under fabrication.

Fig. V. Large-Scale laboratory unit for the production of electrolytic manganese from chloride baths.

From the above general review the present position, to state briefly, is that *it is opportune for the Indian Manganese Industry to give active and immediate consideration to the setting up of large-scale production of electrolytic manganese metal as well as the production of manganese chemicals, chiefly Manganese Sulphate.* For a country of India's size, holding a prominent position in respect of manganese ore, production of a minimum of one ton per day of the metal and five tons per day of the sulphate to begin with, will be a good proposition; the total production, one expects, will surely be "bought". The problem of "selling" may not present any difficulty. As a matter of fact both the products can actually have a very good export-market. Opinions expressed from time to time in well-informed and authentic circles may be cited in this context.

The Industrial Panel[18] on Non-ferrous Metal Industries constituted by the Government of India about the year 1945 said:

"Large exports of minerals of any kind are detrimental to the best interests of the country.....

"The potential uses of manganese are so many that if due to economic reasons private enterprise is unwilling to take up the manufacture of manganese, we feel that the state should take up its manufacture."

The Planning Commission[19] stated:

"The ore should be converted into ferro-manganese and manganese chemicals for export purposes instead of being exported in the raw form".

The Director, Scientific and Industrial Research (Dr. S. S. Bhatnagar, the late) said:

"Indian manganese ore is much superior in quality to that of either U. S. S. R. or Brazil. *There is therefore no meaning in exporting this valuable material to foreign countries at cheap prices and importing the finished goods at high prices.*"

Prof. M. S. Thacker, (now Director-General, Scientific and Industrial Research) in his Presidential Address delivered at the Annual Meeting of the Indian Institute of Metals, Calcutta, observed[20].

"A great deal of raw material is exported. The export of high-grade manganese and chromite ores is an instance..... For copper alloys, manganese and silica are excellent hardening substitutes *and it is therefore very desirable to set up a plant for the manufacture of manganese in India.*"

[18] Report of the Industrial Panel on Non-ferrous Metal Industries, (Planning and Development Dept., Government of India, about the year 1945.

[19] First Five-Year Plan People's edition), January 1953. PP. 168-169.

[20] Thacker, M.S., Trans. Ind. Inst. Metals, Vol. 4, 1950. PP. 6-23.

Dr. Daya Swarup and Dr. B. K. R. Prasad, stated:[21]

"Electro-winning of metals like Manganese, Zinc, Copper etc., direct from their ores is a matter worth considering. *The most important metal to be won by this process is manganese of high purity which is considered to be a potential source of valuable manganese alloys. It can have considerable export market.*"

Messrs. D. N. Dhanboora and J. S. Vatchagandhy observed:[22]

"The low-carbon 18% chromium steels in the alloying range of 4—12% Mn and 0—4% Ni hold considerable promise of being developed industrially to take the place of conventional 18—8 stainless steel for most commercial purposes."

Realising the importance of the development of non-ferrous Industry in India which has grown up during World War II, the Government have recently decided upon constituting a Development Council[23] under the chairmanship of Dr. Antia, formerly the Hony. Secretary to the Industrial Panel on Non-Ferrous Metal Industries, Government of India.

It is thus a matter of satisfaction that both the Government and the mining interests are quite alive to the urgency of the problems relating to the non-ferrous industry. As regards manganese, their efforts, so far, however, appear to be concentrated chiefly on ferro-manganese plants and plants for the beneficiation of low-grade ores.

It is timely that indigenous production of manganese chemicals and also electrolytic manganese metal, (the latter as a part of the general programme of production of virgin metals for alloying purposes), is given due and adequate consideration that it deserves and the same may be included for implementation in the current Five-Year Plan period, at least on a modest scale.

The authors take this opportunity of acknowledging the very kind and keen interest evinced by Dr. K. S. G. Doss, Deputy Director-in-charge, Central Electro-Chemical Research Institute, in the problem of Indian Manganese.

BHILLAI'S FIRST FURNACE TO BE READY IN JUNE

It is learnt, the first of the three Rs. 15 crores blast furnaces for the Bhilai steel project would be ready by the first week of June next. The other two furnaces are expected to be completed by October. In the factory area of the project, a mile and 23 ft. long building is being constructed which will be utilized for the preparation of coaking coal and storing waste materials for manufacturing by-products. The project will be supplied power from the thermal station at Korba which has a capacity to produce 90,000 k.w.s. of power. A stand-by power house is also being constructed in the area.

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FOURTH STEEL PLANT AT BOKARO

According to a statement of Mr. T.T.Krishnamachari, Union Finance Minister, Government of India have tentatively decided to locate the fourth steel plant at Bokaro in Bihar. While speaking on steps to have plants on credit basis, the Union Minister is reported to have observed that in so far as the setting up this fourth steel plant in India is concerned "we would like to make it ourselves if there was to be a fourth steel plant. If, however, there was any aid offer from some country to supply a blast furnace against pig-iron, they would certainly consider it".

[21] B. K. RamPrasad and Daya Swarup: "Applications of electric power to electro-chemical-metallurgical industries in India", at the sectional meeting of the World Power Conference held at New Delhi, 1951.

[22] D. N. Dhanboora and J. S. Vatchagandhy, Trans. Ind. Inst. Metals, Vol. 3, 1949. PP. 309-331.

[23] "The Hindu", January 11, 1957.

Note.—All italics and bold types are of the authors of this paper only. R. S. Dean's "Electrolytic Manganese and Its alloys" provided much of the data cited in this paper, for which authors' acknowledgements are due.

Continuous Electric Furnaces

By Plant Engineer
Wild-Barfield Electric Furnaces Ltd., Herts.

More and more factories are being mechanised for line production. Heat-treatment can be fitted into this scheme of things. Some brief notes on suitable furnaces.

THE age old tendency to regard a heat-treatment shop as a place apart from other sections of a factory, is giving way to the plan of incorporating furnaces in or adjacent to the production line. In the days when pack carburising was the rule, there was much to be said for keeping carburising boxes and compound clear of the rest of the factory. Heat-treatment times were very long and the working conditions far from ideal. Even small components were heat-treated in batches, and the incorporation of furnaces in a production line was not usually seriously considered. In addition, casehardening in a cyanide bath despite precautions contained an element of danger and was undoubtedly better away from the general run of the factory.

Naturally, in such circumstances, handling and other costs tended to be high, and the time taken in transporting treated components from one stage of production to the next was not inconsiderable.

Developments in heat-treatment techniques have led to a far different state of affairs. Gas carburising, for example, is far quicker than the old pack method and much more precise, yet although components requiring only a shallow case may well be treated on a continuous basis, greater case depths are still treated in batch type equipments. Nevertheless, the inherent cleanliness of gas carburising enables an installation to be placed adjacent to a production line without any deterioration of working conditions.

Carbonitriding is rapidly coming to the fore as an alternative to cyaniding, and it has many advantages over the salt bath process. Probably the most important of these is the cleanliness of carbonitriding, there being no need to clean the final product, and without such cleaning salt bath treated work is liable to rust. Furthermore, a carbonitriding furnace can safely be placed right in a production line, and the question of salt storage naturally does not arise. Treatment times for given case depths compare very favourably with those required for cyaniding.

Continuous hardening, normalising, tempering, etc., are not new processes. Furnaces for such have existed for some time, but whereas the production engineer of yesteryear tended to isolate the equipments in a separate heat-treatment building, his counterpart to-day maintains the attitude that such furnaces should be placed in or near the actual production line to save handling costs.

A standard shaker hearth furnace for the continuous carbonitriding of small parts is shown in figure 1.

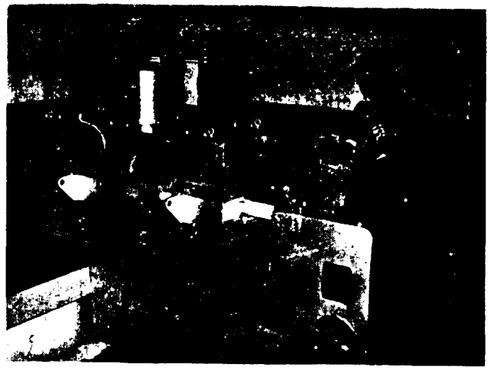

Fig. 1. Shaker hearth furnace for the continuous carbonitriding of small parts.

Similar equipments—not necessarily with a fan—are used for straight hardening and other treatments. For carbonitriding, precise control of progress of work through the chamber is essential if consistency of case depth is to be obtained. With some equipments, the hearth tray design tends to cause difficulty in this respect. In the Wild-Barfield type, however, the tray is ridged from side to side throughout its length, and this form of construction gives the close control of work travel needed. It is further assisted by a variable speed drive operating the tray in conjunction

SHORTAGE OF MATERIALS ETC. HAMPERS PROGRESS OF BHILAI PLANT

According to a report, the progress of the Bhilai steel project whose first phase of work is scheduled to be completed by the end of the next year and which is planned to go into full production by the end of 1959, is presently facing some difficulties due to slow construction work, shortage of raw materials and trained personnel. The report added however that steps are being taken to complete the project, according to the schedule. The construction of the coke oven and by-product plant, blast furnace, open hearth and rolling mill shops are reported to have started already. Over 60,000 cubic metres of earth-work have been done and the first 25,000 cubic metres of concrete have been laid. Reinforced concrete foundations of the first blast furnace and hot blast heaters and the concrete foundation plate of the first coke oven battery are expected to be completed this month. The erection of steel structures are expected to commence soon. Of about 300,000 tons of equipment needed, over 50,000 tons reportedly have already arrived in or was on way to India.

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NEW FERRO-SILICON PLANT AT BHADRAVATI

It is reported that the new Ferro-Silicon Plant at Bhadravati Steel Works is likely to go into production in course of the next two years. The State Government of Mysore reportedly is negotiating an agreement with a Norwegian firm for the supply of the necessary plant and machinery. According to present estimates, the cost of the scheme would be about Rs. 1.5 crores and the capacity of the plant would be about 20,000 tons per annum.

MANGANESE ORE

According to an announcement by the Government of India, it has been decided to continue the system of quota licensing of managanese ore for export for the period July 1957 to June 1958. The announcement added that movement and shipment quotas will be given to shippers and mine-owners equal to 60 per cent of their exports made in 1955 or 1956 to be selected by them. Quota holders will be required to utilise at least 60 per cent of the quotas issued to them for export of manganese ore containing 42 per cent manganese and below. This restriction will, however, not apply to mine-owners who establish to the satisfaction of the Export Trade Controllers that their mines do not produce manganese ore containing less than 42 per cent manganese and to those shippers and mine-owners-exporters who have outstanding commitments for higher grades. All shipments effected on or after 1st July 1957 will be debited to the quota for the year 1957-58.

with coil springs having tension adjustment. By the use of a feed hopper, loaded by a vibrator or other suitable mechanism, and a continuous quench extractor, untreated work can be fed into the furnace and treated work passed to the next production stage.

Where components of differing sizes, such as springs, etc., have to be hardened, it is often more convenient to use a pan conveyor type of equipment, such as that

Fig. 2. Loading end of a pan conveyor furnace. The varied nature of the charge is apparent from the contents of the pans and of the containers in the foreground.

illustrated in figure 2 above. Saving of handling time can frequently be effected by passing trays of work to the operator by means of a gravity roller conveyor. One operator can easily serve two-pan conveyor furnaces, and although hand-loading is necessary, continuous quench extraction can be incorporated to pass the work on, and a smooth output of treated components is readily obtainable.

For small items, such as self-tapping screws and the like, rotary drum furnaces afford a simple, accurate and economical means of heat-treatment whether it is carbonitriding or straight hardening. In figure 3, a typical rotary drum furnace is shown. Components are loaded into the hopper either manually or by a suitable feeding mechanism. After treatment, a continuous quench extractor removes the treated parts. The construction of the furnace is such that the revolving drum forming the chamber acts in the nature of a retort, and this ensures very close control over the atmosphere conditions within it. Thus, when carbonitriding, precise control of case depth is afforded, assisted by a variable speed drive giving flexibility in the rate of drum rotation.

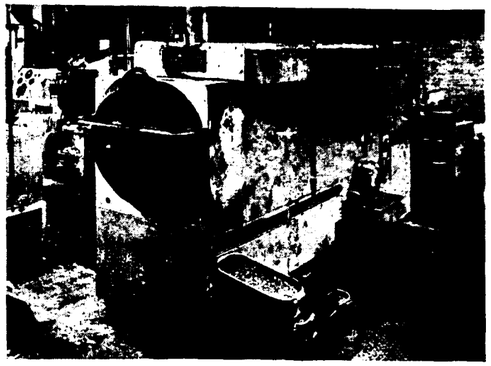


Fig. 3. Typical rotary drum furnace for the continuous hardening or carbonitriding of small components.

Fig. 4. Bright annealing is the process being carried out by this mesh belt conveyor furnace.

A fourth type of furnace that can well form part of a production line is shown in figure 4. It is mesh belt conveyor, suitable for heat-treatment where a quench is not required. Such processes as bright annealing of ferrous and non-ferrous pressings and stampings, normalising, etc., are within the scope of this equipment, which, in common with other continuous furnaces, has a variable speed drive mechanism.

Reliability is probably the most essential characteristic of equipment forming part of a production line, for breakdowns are costly and disruptive. Thus, in all the furnaces here dealt with, special attention has been paid to ensuring that they keep operating under the most arduous conditions, and at any points when complications might possibly arise, a high safety factor is incorporated. In the case of furnace elements, for instance, these are of tubular form supplied at low voltage by a transformer. They are always operating well within their capacity and any chance of failure is very slight. Nevertheless, an additional safeguard is provided by fitting the furnaces with a fusible pattern excess temperature cut-out. By this means, accidental overheating of the elements is obviated, as in such circumstances the supply to them is automatically cut off. Replacement of the thermal fuse of the excess temperature cut-out is a simple and rapid operation.

Naturally, outputs of all these equipments vary according to the work being treated, the nature of the treatment and the size of the furnace. The table below gives fair average output figures of typical units and the power consumption required to maintain them when dealing with such outputs.

From the foregoing, it will be apparent that continuous furnaces offer an economical and effective means of carrying out heat-treatments on a production line basis. Taking the overall picture, electric furnaces can reduce handling costs, can be operated with complete safety and the nature of their construction is such that the maximum output is obtainable from a comparatively small occupied floor space, and with good working conditions. In addition, being for the greater part completely automatic in operation once the necessary controls have been set, they can be attended by virtually unskilled labour. Thus when consideration is being given to the layout of a new production line, or to the modernising of an old one, it may well be that continuous electric furnaces can bridge the gap between the erstwhile separate heat-treatment shop and the post-treatment section of the manufacturing process.

These notes have covered resistance furnaces only. Induction heating equipments form another group very much akin to machine tools. In a later issue, it is hoped to give some notes on the employment of such equipment in the production line.

FURNACE	Average output up to	TREATMENT	Case Depth	COMPONENTS	Approx. power consumption kWh/hr.
Shaker Hearth	22 25 lb./hr. 9.9/11.3 kg/hr.	Carbonitriding	0.007" 0.18 mm.	Typewriter parts and similar components	8.0
	75 lb./hr. 34.0 kg/hr.	Hardening	—	Cotter pins, small pressings, etc.	10.0
Rotary Drum	115 lb./hr. 52.2 kg/hr.	Carbonitriding	0.005" 0.13 mm.	Self-tapping screws, etc.	15.0
	200/250 lb./hr. 90.7/113.4 kg/hr.	Hardening	—	Small symmetrical parts	28.0
Pan Conveyor	200 250 lb./hr. 90.7 113.4 kg hr.	Hardening	—	Bolts, springs, hand tools, etc.	40.0
Mesh Belt Conveyor	200 lb./hr. 90.7 kg hr.	Bright Annealing	—	Pressings and stampings	34.0

Average output figures of typical continuous electric furnaces.

Savagraph Vat Emulsion Printing Process

By Technical Publicity Officer of

E. I. du Pont de Nemours & Company (Inc.)

SAVAGRAPH is the term used to identify a new Du Pont development of outstanding significance for the printing of cellulosic fiber fabrics. The new technique is based on previous continuous dyeing experience with the Du Pont Pad-Steam Continuous Dyeing Process and the use of "Vantasol" vat dyes, Du Pont's new line of especially prepared vat dye pastes.

The Savagraph process incorporates "Vantasol" dyes in a unique water-in-oil emulsion. The emulsion is printed onto fabrics from conventional equipment and then dried. The prints are developed by impregnation with reducing agents and alkali, steaming and then oxidizing and soaping. Significant features of the process are :

Stock pastes have good stability.

High-speed printing is possible.

Prints can be held and aged when desired.

Rope soaping is not necessary to develop maximum fastness.

Smoothness and sharpness of print are unexcelled.

Fastness properties of finished print are excellent.

Better color value is obtained in comparison with conventional vat printing.

A wide range of "Vantasol" vat dyes is available.

Aniline black and stabilized azoic dyes can be used successfully in prints along with "Vantasol" dyes in the Savagraph process. Where Aniline black is used, the printed material should be first neutral or acid aged and then developed by the Savagraph method. When stabilized azoics are employed in the pattern it is necessary to include a protective agent such as "Sitol" Flakes oxidizing agent in the printing paste. After printing and drying, acid aging is necessary to fix the azoic dye followed by Savagraph development.

When all three types of dyes are used in the same pattern it is recommended that the Aniline black and azoic dyes be developed by acid aging only before final Savagraph development of the "Vantasol" dyes.

The following information presents the steps to follow in preparing the emulsion and printing paste and fixation of the dye. Also included is a summary of the required equipment and materials for the Savagraph operation as well as a few cautions to be observed.

PREPARATION OF THE EMULSION

THICKENER OR CLEAR

Five parts (by volume) of the specially prepared resin concentrate, "Methacrol" PR resin solution, is measured into a container and agitated while adding the required amount of suitable hydrocarbon solvent, such as "Varsol" No. 2*, which can be varied slightly, depending on the final viscosity desired. It is a fundamental principle of water-in-oil emulsions that the viscosity can be increased by addition of water or decreased by addition of solvent; such additions may be made later to the print paste, as required. In general, however, optimum stability and viscosity are obtained with 30 parts (by volume) of the solvent.

Before emulsifying, the water should be adjusted to pH 9 to 10 with soda ash and should contain 0.25 oz./gal. common salt. Enough water to make a total of 100 parts (by volume) is added slowly, during emulsification with a mixer, such as the Eppenbach** homogenizer or Lawrence Mill † until a smooth, stable, water-in-oil emulsion is produced.

It is suggested that in a 55-gallon drum a 3 H. P. homogenizer with a shaft speed of 2500 rpm. or higher with close clearances between stator and rotor blades be used for proper emulsification. For best results, the water should be added to the resin-solvent mix over ten minutes while mixing. After all the water has been added, homogenization should be continued for five to seven minutes longer.

* "Varsol" No. 2, as employed in the United States, is said by the manufacturer, Esso Standard Oil Company, to have an approximate composition of 31.0% paraffins, 34.5% naphthenes and 34.5% aromatics. It is possible that other hydrocarbon solvents might produce equally satisfactory results, but it is suggested that in initial practical trials of the process, a solvent approximating the above composition and properties be employed

** Gifford-Wood Company, Hudson, New York.

† Lawrence Pump and Engine Company, Lawrence, Mass.

PREPARATION OF THE PRINT PASTE

For convenient operation, the practice of making floor standards is strongly recommended. It is suggested that they be made by mixing thoroughly

5 parts by volume "Methacrol" PR resin solution,

30 parts by volume "Varsol" No. 2,

45 to 40 parts by volume water, and

20 to 25 parts by volume "Vantasol" dye paste

The water and the dye paste are added to the mixture of "Methacrol" PR and solvent while agitating vigorously, preferably with a high-speed mixer, such as the Eppenbach. As noted previously, the viscosity can be varied, as desired, by varying the amounts of water and solvent.

The floor standards are mixed and cut with clear in the normal manner to produce a given shade. Only sufficient mixing to insure uniformity of the batch is required. With some dyes, it may be necessary to thin the floor standards or the print pastes. This can be accomplished by the gradual addition of small amounts of solvent while mixing.

Printing is done on conventional equipment but best results are obtained on intaglio engraved rolls etched approximately 40 to 50 lines per inch for heavy materials and 60 to 70 lines per inch for lightweight materials. The optimum depth of engraving would, of course, have to be determined from data obtained under conditions of use. The emulsions can also be applied by screen printing where the goods are not printed on waxed tables.

FIXATION OF THE DYE

After printing, the fabric is dried at a temperature not exceeding 250 F. until all the solvent is removed. The print may then be developed immediately or held for later development as desired. The prints are stable to storage at this stage. Development consists of impregnating the fabric with a solution containing about 50 g l. caustic soda and 50 g l. Du Pont Hydrosulfite Conc. at room temperature. To insure rapid wetting of the printed fabric, it is recommended that 1.0 g/l. "Petrowet" WN surface active agent, which functions in highly alkaline media, be incorporated in the pad liquor. The use of this particular agent is suggested because many other commercially popular wetting agents, especially nonionics, have failed to function properly in this process. Alternatively, 1.0 to 2.0 g/l. cresylic acid can be used. In the event that the reducing liquor foams excessively as the printed fabric is passed through it, a compatible antifoam agent, e. g., Anti-Foam Agent No. 60 (General Electric Company), may be added. (For best results, Anti-Foam Agent No. 60 should be dispersed in water before adding to the pad liquor.)

A conventional two-roll padder with a shallow box is used. Best results are obtained when the steel roll is located on the bottom and the goods are padded face down so that the printed side will run on the metal surface. Light goods which wet out rapidly should be nip-padded but heavy goods must be dip-padded for optimum results. A good padder is essential to insure a uniform liquor pickup both across the piece and lengthwise throughout the run of between 75 and 95% on the weight of the goods. Pickup in nip padding may be increased by slight thickening with "Flotex" or other modified starch stable in caustic.

From the padder, the fabric passes directly into a special steamer constructed so that the face of the goods does not contact any carrying rolls. The distance between the liquor level and the nip should be as short as possible. It is even more important that the time required for passage of the fabric from the nip to the steamer be as short as possible, since even a relatively few seconds exposure to the atmosphere can cause deterioration of the reducing agent and thereby prevent complete reduction of the dye in the steamer. Consideration should be given to the installation of an extended throat on the entry end of the steamer to minimize the distance of travel through which the impregnated fabric must pass before entering the saturated steam atmosphere. The temperature of the steamer should be maintained at about 225 F.; coils or chests should be installed, if necessary, to sustain this temperature and prevent dripping. Sufficient steam to insure air-free conditions is required but excessive use of steam to such an extent that it flows out of the throat and heats the padder rolls should be avoided. Steaming time will depend to some extent on the weight of the goods being processed and to a lesser extent on the depth of color being printed. In general, however, 80×80 fabrics or lighter can be satisfactorily steamed for 20 seconds, while heavier fabrics may require additional steaming time for complete dye fixation. The steamed fabric preferably passes through

a water seal into the first box of an open soaping range where it is thoroughly rinsed in cold running water. The second and third boxes should contain a suitable oxidizing agent to which acetic acid can be added to neutralize the excess alkalinity. Particularly good results are obtained using 20 g/l. "Albone" 35 hydrogen peroxide at 140° F. The remaining boxes can be used for soaping and rinsing.

In the Savagraph process of printing, the dye is completely fixed in the fiber. The vehicle used has no affinity for the vat leuco and is completely hydrolyzed during the steaming operation. Therefore, extensive and vigorous soaping is not as essential here to produce good fastness as it is in conventional procedures where large quantities of starchlike products are used as vehicles. The main function of soaping in the new process is to remove traces of chemicals and to develop the true shade of the vat dye in cases where a pronounced shade change would take place in subsequent washings. After soaping, the prints are dried and finished in the normal manner.

SUMMARY OF ESSENTIALS FOR SAVAGRAPH PROCESS OPERATION

I. *Equipment*

Homogenizer:

Eppenbach, Shear-Flo, or Lawrence "Vortex" are acceptable. Other efficient homogenizers or colloid mills ordinarily used for preparing water-in-oil printing emulsions can be used. It is important that the clearance between stator and rotor blades be close to design specifications and that the mill be in first class condition.

Containers:

Small batches of clear are best prepared in 55-gallon drums. The preparation of large batches is dependent upon individual requirements and specific recommendations can be made covering any particular situation.

Padder:

Two-bowl, as described in text on page 25

Flash Ager

II *Materials*

Resin:

"Methacrol" PR resin solution.

Solvent:

"Varsol" No. 2 is recommended. See footnote on page 24.

Water:

Adjusted to pH 9 to 10 with soda ash. 2.0 g/l. common salt (sodium chloride) dissolved therein.

Dyes:

"Vantasol" vat dyes.

Chemical Padding Solution:

50 g/l. sodium hydroxide.
50 g/l. sodium hydrosulfite, and
1 g l. "Petrowet" WN surface active agent.

III. *Preparation of Clear*

Measure into container
5 parts by volume "Methacrol" PR.
Start mixer. Add
30 parts by volume solvent
Add over 10 minutes, while homogenizing,
65 parts by volume water
adjusted as directed in II. Continue mixing five to seven minutes longer.

IV. *Preparation of Floor Standard*

Measure into container
5 parts by volume "Methacrol" PR.
Start mixer. Add
30 parts by volume solvent.
Add over five minutes, while homogenizing,
45 to 40 parts by volume water
adjusted as directed in II, and then over another five minutes
20 to 25 parts by volume "Vantasol" vat dye paste.
Continue mixing for five to seven minutes longer.

V. *Cautions*

1. The Savagraph process is useful for applying dyes to cotton, regenerated cellulose rayons, and silk. Significant saponification would be encountered if the process were used in printing cellulose acetate.

2. In screen printing, the use of vax tables should be avoided, since the external solvent phase of the emulsion may soften the wax and cause the fabric to lift. Cloth tables or tables covered with a solvent-resistant adhesive can be used with all fabric constructions.

3. It is important that water be in the pH range of 9 to 10. At a lower pH, thin, unstable emulsions can result.

4. Be sure to agitate "Methacrol" PR resin solution while adding solvent. Add water and/or "Vantasol" dye paste to the solvent or emulsion slowly while homogenizing. Continued agitation will not harm water-in-oil emulsions.

5. As with all pigment prints, transfer of color from printed to unprinted areas may occur, particularly with heavy shades, if the undeveloped prints are subjected to excessive handling, rubbing or chafing. This will appear as smudges on development.

(Continued on page 27)

Super Speed Low-Built Looms

By A Technical Correspondent

A NEW range of low built looms, comprising two basic models, HST and MRT, for weaving light and medium weight fabrics, have been developed by British Northrop Limited, and incorporate many new features for automatic weaving machinery.

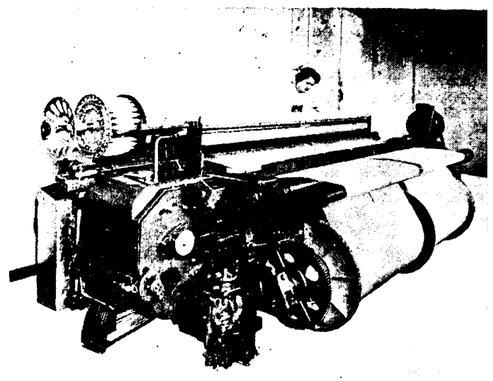
The main purpose in the new topless range is one of dynamics—to introduce the highest possible loom speeds consistent with the maximum operational weaving efficiency. This is achieved by the low centre of gravity created by the lack of superstructure, low mounted dobby and heald motion, which reduces the loom vibration to a minimum, and thus permits the increase in speed hitherto unobtainable in other types of loom constructions—even in the Northrop range.

As an example of this feature, the HST 44 model was seen running in the Northrop Showroom at a speed of 220 p. p. m. and the MRT 65 model at 190 p. p. m. In general, it may be stated that the speed range, according to the reed space for the HST model lies in the region of 200—250 p. p. m. while the MRT, again depending upon the reed space and also whether single or multi-shuttle, in the range of 175—230 p. p. m. Tests, however, have revealed even greater speeds for both of these models during the initial development period.

ALL-PURPOSE RANGE

To appreciate the distinction between the two looms the HST model is essentially a single shuttle loom for widths up to 60 in. while the MRT model is available as either a single shuttle, two-box weft mixing or two to four colour loom in width up to 85 in. The extreme flexibility of both these models permits a wide range of fabrics to be produced from all types of spun yarns. Both looms are fitted as standard with positive side cam shedding with up to twelve shafts. The MRT models can, if necessary, be fitted with a positive dobby for up to twenty shaft weaves.

The heald undermotion is extremely well designed with long wooden streamers connecting to the dobby



Rear view of the Northrop Model MRT loom, showing the low mounted dobby, Differential let-off, and other novel features which provide for precision mechanical control and maximum overhead visibility.

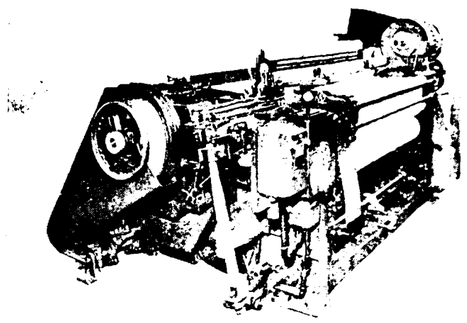
(Continued from page 26)

jacks and treadles. An interesting feature of this mechanism is to be seen in the simple knuckle joint which is designed to connect the shafts to the treadles and yet which cannot slip out in motion. Warp gaiting and replacement is easily and quickly accomplished in both of these looms either with the dobby or the cam motion, and a lever arrangement ensures that the heald lift is vertical and parallel in operation.

PUSH-BUTTON CONTROL

The drive is achieved with a continuous running high torque loom motor operating through a cone clutch direct on the crankshaft, or, in the MRT model, back geared on to the tappet shaft. Roller bearings are used throughout especially for the crankshaft. An interesting and novel feature is to be found incorporated in the centralised starting handle unit at the left hand side of the loom. A push button for stopping the loom is fitted to all the models in this new range, which automatically stops the loom on top centre with the shuttle in the left hand box, irrespective of the crank position at the time. The advantage of this device removes the tendency for the weaver to "feel" for the shuttle as before, and constitutes a greater safety factor for the operator and in avoiding warp damage. The starting handle is also used for reversing and inching the sley and incorporates a safety stop when loom adjustments are made.

The parallel underpick motion is equipped with triple bearing pick shafts while an additional safety factor is to be found in the foot operated shuttle ejector for the battery side operated through a pedal. The makers have studied the human safety factors thoroughly on these new models, and are to be congratulated in achieving high speeds together with complete personal safety. Double coil frog springs are fitted in the loom frame for increased shuttle protection and clearance if the shuttle is trapped in the shed when "banging-off", while the completely re-designed shuttle easing motion, driven by the crank arms, removes all the pressure on the shuttle when picking, and affords greater accuracy to the shuttle flight. A further



The centralised starting handle unit and push button stop control is featured in this view of the HST model.

improvement is to be found in the micrometer adjustment to the box fronts for controlling the shuttle position at both ends, and in the floating swells to promote effective shuttle checking.

A powerful brake is incorporated to stop the loom on top centre for a warp break, and on back centre for a weft break. On the MRT model with a centre weft fork the sley will stop on front of the fell of the cloth for a weft break before the pick is beaten up.

The Bartlett let-off motion fitted as standard on all looms, utilizes extra large backrests to stand up to the warp tension when weaving high sett fabrics and large diameter beams. Beam flanges up to 26 in. may be accommodated in all models in the new range.

A new two or four colour rotary battery may be fitted as required to the MRT box loom. This new mechanism will accommodate thirty-six pirns. For the HST model a single shuttle battery is fitted as standard, with a new type of positive cam opening and closing shuttle eye thread cutter.

SEARCH FOR OIL IN WEST BENGAL

The search for oil-bearing spots in the West Bengal basin, believed to contain one of the oil belts, has begun. Recently, the Standard Vacuum Oil Company started the drilling operations near Burdwan in the basin. The operations are being conducted under the Indo-Stanvac project in which the Union Government holds one-fourth of the total share capital. The project was decided upon in 1954 and aims at searching for mineral oil in an area of 10,000 square miles in the West Bengal basin. The preliminary explorations began in 1955 and were completed early this year.

HIGH VACUUM IN INDUSTRY

By A Technical Correspondent

HIGH Vacuum is the Godfather of our knowledge about the structure of matter and the atom. In vacuum we made the first direct acquaintance with Electrons, Ions, X-rays, Isotopes, etc. Wireless and Television depend on our ability to produce high vacua on an industrial scale. High vacuum is necessary to accelerate elementary particles in Cyclotrons, Bevatrons and Cosmotrons to energies at which they are able to transmute the elements at collision.

The scientist and the electronic industry are mostly concerned with the evacuation of relatively small volumes and small pumping systems and, although the industrial potentialities of vacuum for certain industrial processes have been realised long before the last war, the demand for large volumes and efficient pumps with shortest operational time could not be satisfied. It was the Atomic Energy Programme during the war which stimulated the development of vacuum technique on a large scale, with very powerful pumping systems and to-day it is no problem to evacuate a volume of several hundred cubic feet within a few minutes to a pressure of about one-hundred—millionth part of normal atmospheric pressure. After the war industry was quick to take advantage of this development, be it for the improvement of established techniques or for the development of new industrial processes and methods. This expansion of vacuum technique into many, varied branches of technology is still progressing and particularly the metallurgist takes increasing advantage of vacuum. For instance, the metallurgy of Titanium is strongly tied up with high vacuum technique.

Within the available space it would be impossible to discuss all industries in which vacuum technique has found a permanent and expanding home. Instead we shall discuss the characteristic features of vacuum, how they affect the physical and chemical properties of matter and how they can be put to industrial use. To give, at first, an idea of the wide range of industrial fields in which vacuum plant is to-day a permanent piece of equipment.

The importance of high vacuum technique in electronics is well known. The Optical Industry uses high vacuum for the deposition of transparent films on lens surfaces as anti-reflection films (blooming) and there is hardly an optical instrument or camera on the market without bloomed lenses.

The metallurgist is able to produce purer and gas-free metals and in many cases to separate metals from the ore in a simple and economic process under vacuum.

Chemists separate organic substances with close boiling point with great efficiency in vacuum distillation.

Biologists are able to dehydrate Blood Serum, Antibiotics and Virus and to preserve them for long periods of time in readily soluble condition by vacuum sublimation of the water from the frozen state. The lives of thousands of American Soldiers have been saved by blood transfusion with vacuum dehydrated blood brought from the States.

The Plastics industry produces metal films on plastics by vacuum evaporation for decorative purposes or to make the surface electrically conductive.

Vacuum technique is used for the production of metal rectifiers, for the growth of crystals, transistors and for optical purposes.

CHARACTERISTIC FEATURES OF VACUUM

(1) Vacuum in the strict sense, as a completely empty space, is not realisable. We call a High Vacuum a space in which the air is rarified to an extent at which the molecules of the residual air are so far apart that they move across the space without colliding with each other and other molecules or atoms in the same space. It is obvious that no chemical reaction can take place in the absence of collisions. Let us illustrate this very important feature on a two dimensional mechanical model. Imagine the air molecules to be balls on a billiard table. At conditions equivalent to atmospheric pressure the balls would be densely crowded, with only a fraction of an inch interspace between neighbouring balls. A new ball pushed along the table would have to undergo many collisions with oxygen molecules before penetrating across the table and each collision is a chance for oxidisation. Under conditions of high vacuum only a few balls are left on the table and a new ball can move in a straight path across the table without collision. Accordingly, vacuum is a chemically inert space.

(2) The rarification of air molecules is also the cause for the depression of the boiling points of liquids under vacuum. When a liquid is heated the molecules or atoms are in thermal agitation and some of them may acquire sufficient acceleration towards the surface to penetrate it and to escape against the attraction by neighbour molecules. We speak about the vapour pressure of the liquid and if this pressure is large enough to balance and overcome the pressure of the atmosphere above the liquid, the liquid boils. The denser the molecules in this atmosphere the more difficult will it be for a molecule from the liquid to escape, or the higher the pressure of the atmosphere, the higher the boiling point (Pressure Cooker). Here too our two dimensional mechanical model may serve to illustrate the dependence of boiling temperature on pressure. Imagine a few balls in one pocket of the billiard table and they are accelerated in order to get them on top of the table. At atmospheric pressure, when the top of the table is densely occupied by balls, balls from the pocket will recoil from those above and it will require great accelerations in order to penetrate on to the table. In the vacuum, with only a few balls on top of the table a smaller force will be sufficient to get a ball on to the table, and once on the table the ball will continue to move across the table without collision till it strikes the opposite wall or any other obstruction. The mechanical energy corresponds to the temperature in the case of evaporation and the boiling point of metals is under vacuum several hundred degrees lower than in atmosphere.

(3) Vacuum has a similar effect on the decomposition or dissociation of inorganic oxides, carbonates, sulphides etc., which, under vacuum at lower temperature, dissociate into a metal and a gas -the gas being removed by the pumps. The metal itself can be volatile at the temperature of dissociation and condensed on a cooled surface.

TYPICAL INDUSTRIAL APPLICATIONS OF VACUUM

The preceding survey of the characteristic properties of vacuum suggests by itself all possible useful industrial applications and we can confine ourselves to a few typical processes:—

Vacuum is indispensable for the production of gas free metals. It is applied in the steel industry for gas free castings, particularly from electric furnace steel, which contains fairly large percentage of hydrogen which has a detrimental effect on the mechanical properties. Up to 150 tons ingots are cast under vacuum.

Vacuum is also applied for sintering on an ever increasing scale. The fine grain of a metal powder compact carries appreciable quantities of absorbed air and moisture and heating in air would lead to considerable corrosion. In many instances sintering was carried out in a neutral atmosphere, like hydrogen, but vacuum is gaining more and more ground.

Under atmospheric pressure the boiling point of most metals is in the region of 2,000°C and it would be difficult and often impossible to produce metal vapour and to separate metals from a mixture by distillation analoguous to the distillation of organic liquids by the chemist. Apart from the danger of oxidisation, it would be difficult to find a refractory for the high temperatures and it would be difficult to collect and to separate the fractions.

In the preceding section it has been shown, that liquids boil at much lower temperatures under vacuum, that there is no oxidisation and that the atoms leave the melt unobstructed in straight paths, till they reach a surface on which they condense. This method of vacuum distillation is industrially applied for the purification of metals, particularly if the solute and the solvent have great differences in vapour pressure at a given temperature, so that one evaporates in overwhelming proportion, to be condensed on a cooled surface. The same principle is applied to separate a metal from the ore by a reduction process in which one component is volatile under conditions of vacuum and condensed. This process has been applied for the production of Magnesium from Dolomite by reduction with Silicon and vacuum condensation of the magnesium. Also Potassium has been isolated in this manner.

Fig. 1. Type EH6a High Vacuum Evaporation Coating Equipment.

In the optical and plastics industries vacuum evaporation opened a new field. Silver surface mirrors tarnish quickly and the reflectivity of silver is less than that of aluminium. High vacuum is the only practicable method to produce aluminium films of high reflectivity. The plastics industry uses vacuum evaporation for decorative coatings on plastics. The great majority of car headlamp reflectors are aluminised by vacuum evaporation. Fig. 1 shows a typical High Vacuum evaporator, used in the optical and plastics industries.

Vacuum evaporation is not confined to metals, any substance can be vacuum evaporated, provided it is chemically stable at the evaporating temperature.

The entire production of Pennicillin and many other antibiotics is based on vacuum freeze drying. At low pressures ice is in equilibrium with water vapour and in supplying the latent heat of fusion, ice does not melt, but sublimes. This makes it possible to dry a substance at very low temperature, thus avoiding chemical decomposition.

CONSTRUCTION OF A VACUUM PLANT

In the case of a process carried out in a medium vacuum at pressures of the order of tenth of mm. Hg., rotary pumps alone are used. Such pumps are available with displacements in the order of 1000 cfm. At pressures of the order of 1/10000 mm. Hg., where it is a question of trapping and removing individual free molecules, such pumps are very inefficient. In this high vacuum range oil vapour pumps are in use supported by rotary pumps for the exhaust. A vacuum plant requires the operation of a number of valves at various stages of progressive evacuation and in larger plant these valve operations are automatically controlled by signals from pressure gauges. The heat for evaporation, sintering or melting can be supplied by resistance heating, induction or arc heating. For the evaporation of small quantities resistance heating in direct contact with the charge is prevalent. For sintering where larger quantities are involved, radiant heating from a resistance heater of graphite or a refractory metal can be used or from a liner heated by eddycurrents from a high frequency induction coil, or the charge itself can be coupled to the induction coil, particularly in the case of ferro-magnetic charges. Arc heating is in use for the melting of high refractory

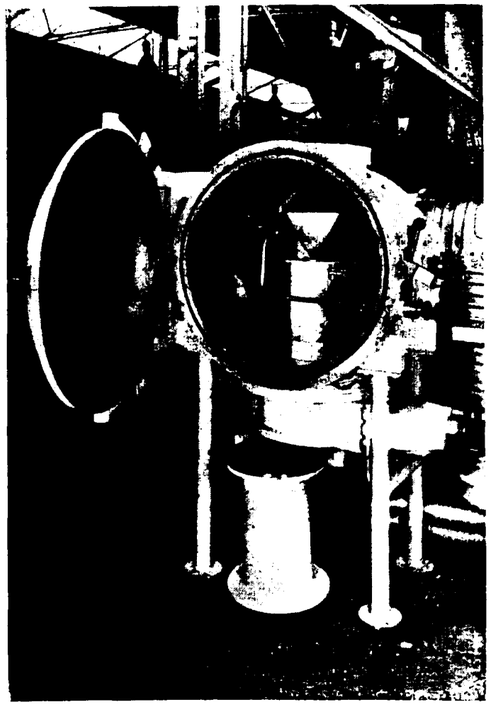


Fig. 2. Interior of F25H Vacuum Furnace Showing :— Moveable Thermocouple, Charge Buckets, Crucible, Bottom Pouring Mechanism, Casting or Mould Chamber. Induction Coil and Radiation Shields removed for clarity.

(Continued on page 33)

Elsworth Ltd.'s Contribution to Woodworking Industry

HISTORY

THIS firm was established in 1840 and has occupied three sites in Sheffield, the latest being at Herries Road South where a modern single storey factory was erected in 1952. This factory is on the outskirts of Sheffield, with all modern conveniences and ample ground for future developments. It was specially designed for the manufacture of Circular Saws, Narrow and Wide Bandsaws, and Machine Knives for the woodworking industry, products which this firm has made for so long and for which it is renowned. A feature of the building is the north-light wall and roof windows admitting no direct sunlight, so preventing reflection from the highly polished steel saws.

CIRCULAR SAWS

Elsworth's "PROPELLER" brand Circular Saws for the woodworking industry are shipped to all parts of the world. They range in diameter from 4" to 84". The smallest saws are used on portable tools for very light jobs, the largest diameters break down huge tree trunks into planks. Circular Saws are made by highly-skilled craftsmen who spend a life-time at their trade and frequently pass on their skill from father to son through many generations.

The art of saw-making is to make a saw which will cut true and in a straight line through all conditions of timber, i. e. knots, cross grains, and uneven densities. This involves a correctly shaped tooth for each application and tensioning the steel so that, when running at speed, the saw will not deviate in the cut. Tensioning is done by means of hammer blows, with the saw placed

(Continued from page 32)

metals, like Molybdenum, Tantalum, etc. The vacuum chamber contains jigs for the support of the objects which are to be metallised. They can be simply or planetary rotating. Vacuum Furnaces contain moveable thermocouples, buckets for the addition of charges during melting, radiation shields and a moveable lid. Fig. 2 shows the interior equipment of a vacuum furnace.

FUTURE DEVELOPMENT

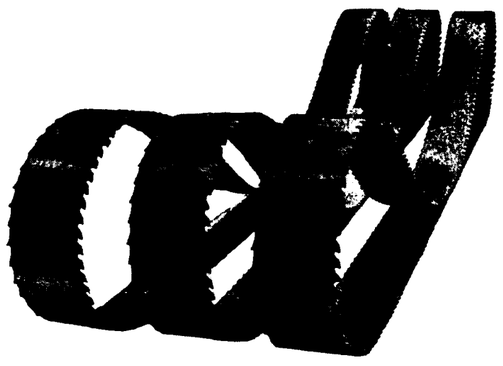
In the main vacuum technique is still a batch process and although there is no fundamental limit for the size of chamber which can be evacuated to lowest pressures with a suitable pumping system, there is an economical limit to the size of the plant as the processing time increases with the increase of enclosed surface area. All surfaces carry a strongly absorbed layer of gas which is only slowly released into the vacuum. Developments of Vacuum Plant for continuous operation, from atmosphere on the intake to atmosphere on the outlet, are on the way but until such plant is available on a scale satisfying the demands of large scale production, vacuum in industry will be confined to special products of high quality and medium quantity.

on a specially designed anvil. Our illustration shows a variety of saws with different shaped teeth.

A new development of this firm is their "Hard-Tip" Circular Saws which have deposited hard metal on the teeth to cut the abrasive timbers which are now being imported into many countries from West Africa and other tropical sources.

BAND SAWS

These are made from flexible ribbon steel and are in two main groups. The narrower saws, and they are made down to 1 8" wide, are for use on small vertical machines for cutting round small curves in plywood and other thin material. The larger saws, for cutting logs into planks and re-sawing planks into smaller sections, are used on large vertical and horizontal machines in sawmills all over the world. Our illustration shows huge blades 60 ft. long × 16" wide × 1 8" thick which were made for one of the largest machines in existence in Canada.



Here again Bandsaw-making is an art with meticulous care being taken in tensioning the blade and sharpening and setting the teeth so that the minimum amount of waste occurs in the cut. Highly skilled men, known as saw doctors, are employed by the large sawmills to maintain these saws in proper working order.

MACHINE KNIVES

These are made to fine limits of accuracy, using the latest heat treatment furnaces and precision grinding machines so that they meet the requirements of the modern high speed planing and moulding machines. Very high speeds are encountered and Elsworth's "GILT EDGE" Super High Speed Steel Woodworking Machine Knives have been developed to meet the tremendous strain imposed by these conditions. There are some machines, e. g. surfacing and thicknessing machines, requiring thin knives only 1 8" thick to run in their circular cutterblocks. There are moulding machines with square cutterblocks requiring 3 8" or 7 16" thick knives in a variety of shapes. There are also tenoning, spindle moulding and other specialised machines each requiring various shaped knives in a large number of sizes. Our illustration shows an assortment of these knives.

CONCLUSION

The woodworking industry stretches from the Arctic Circle to the Equator and to the South American and Australasian Continents. Timber is a living commodity which requires great study in its working. Elsworth Ltd. have for 117 years studied the requirements of the woodworking industry and from their accumulated experience can advise on the many problems which arise. Their agents in India are Messrs. Gaytee & Company Janmabhoomi Chambers, Fort Street, Fort, Bombay.

DIESEL ENGINES FROM U.S.A.

According to a report, the Railway Board of the Government of India is likely to finalize an order with Alco Products Inc. of New York for the purchase of one hundred 2,000-horsepower diesel locomotives at an estimated cost of 107 million rupees. It is understood that 20 of the locomotives are to be shipped from the United States in June-August this year and the remaining 80 locomotives are expected to arrive in early 1958.

The development of mechanical tests and their value in relation to design

PART—II STRESS IN RAILWAY MATERIALS

(Continued from Vol. I, No. 3—March 57 Edition)

By S. Ramanujam, M. A., A. I. M., A. R. I. C., M. Inst. Metals
Dy. Director, Railway Testing & Research Sub-centre, Chittaranjan.

RAILWAY materials have to withstand dynamic loads. The journal of a carriage axle is subject to alternate tension and compression with each revolution. The driving axles of a locomotive are subjected to these stresses due to the load as well as the alternate action of the steam in the cylinder. The rails are also subjected to the same by every pair of wheels that pass over them. In the case of connecting, coupling and piston rods the stresses are not only repeated but also reversed from tension to compression and are also of varying intensity. It is no wonder therefore that by far the greatest proportion of railway steel failure are by fatigue due to repeated overstressing above the endurance limit on account of local causes such as scratches, tool marks etc. As such average or calculated stresses have no meaning.

A general survey of failures of loco. parts shows that in ninetynine cases out of hundred the metal is high grade. Tests for strength and ductility, chemical analysis for composition and microscopic examination for structure and cleanliness indicated nothing abnormal. Still they failed because of errors in design, indifferent machining or some seemingly minor details like tool marks. The story of these failures is a tale of notches, nicks, kew-ways, oil holes, screw threads, scratches, quenching cracks, short changes in section, poor fillets, inclusions, corrosion pits and the like.

The engineering developments in transport and particularly the increase in live loads and in speed have introduced an important increase in the static and dynamic stresses in the rails. When a live load passes over a track at speed in addition to its own weight, additional forces are imposed on the structure arising from irregularity of track and features inherent in the design of a locomotive. The rail joint effect gives rise to a vertical shock on the track. The parts of a locomotive which move relative to the frame can be divided into two classes, viz., those which revolve and those which reciprocate. At first, designs balanced only the revolving parts.

As unbalanced reciprocating masses tend to shake the locomotive, about 1845, weights were introduced into wheels to balance these also in the plane of reciprocation (horizontal plane). This however left the revolving masses unbalanced in the vertical plane giving rise to the problem of hammer blow which varies as the square of speed. When the train is moving slowly, impact (which comprises hammer blow, rail joint effect, wheel and track irregularities) is negligible. For instance, according to the report of the British Bridge Stress Committee (1928), hammer blow due to unbalanced revolving masses at a speed of 17 miles (axle load 17.4 tons and handling 1000 tons) was 2 tons while it became 28½ tons at 4 times the speed.

With dynamic loads, there is also the problem of resonance at certain speeds when the natural frequency of railway bridges happens to coincide with the frequency of revolution of locomotives. For a span of 80 feet, the natural frequency would lie between 5½ to 8½ oscillations/sec. while the frequency of revolution of loco. wheels in the case of express trains is not more than 8 revolutions/Sec.

In recent years, owing to marked savings in cost, there has been a growing tendency to replace castings by fabricated steel built up from sheets. This is specially so where small quantities are involved when the cost of a pattern would be excessive. For instance, the saddle mounted between the frames of a locomotive to support the smoke box of the boiler manufactured as a steel casting 1½ in. section weighs about 1 ton. A steel fabricated saddle manufactured from 1 in steel plate will have greater strength while being cheaper and lighter (12 cwts. in weight).

In structures such as the boiler shell, tanks etc. which have hitherto been built up by riveting of steel sections junctions of plates have to be supported by butt straps and angle rings. In fire boxes, a riveted lap joint was the accepted practice. In the U. K. though higher speeds and trains of greater weight were

required, the total weight of engine and tender was limited by the strength of bridges while only a maximum weight of 21 tons on any one pair of wheels was permitted by the track. This necessitated particular attention to the reduction of weight wherever possible. Hence, completely welded steel fire boxes were introduced in 1945 in the construction of 'Merchant Navy' class of Locomotives. The substitution of riveting by arc welding resulted in the elimination of lap joints and thick fire hole rings, reduction in overheating of lap joints and unequal stresses while giving greater elasticity. The more resilient construction free from unnecessary stiffened joints also reacted better to shocks during shunting. In view of these developments, new requirements like weldability, and fatigue strength were added to the old stipulation regarding chemical composition, tensile properties and impact resistance. With the continual increase in axle loads, heavier revolving masses and train speeds, the need for suitable material of proper design both in the track and the rolling stock has become of paramount importance.

REQUIREMENTS OF RAILS

Among track materials, none is subjected to more complex stresses and strains than the rails. Exposed to weather at all times and sometimes to sealine corroding atmospheres, they are subjected to heavy compression and bending stresses, shock vibration and wear.

Due to the various requirements of rails which are at times contradictory and the many indeterminate factors which affect dynamic loading, such as nosing, spring action, hammer blow, conditions of maintenance, rail design has not followed the rational methods usually adopted in the design of most engineering structures. Changes in the quality of steel, weight and design have usually come as a result of study of failures of existing materials and designs

The load of a wheel is concentrated on an extremely small surface of the rail. If the load on this small area of contact is heavy enough, the metal will flow. The top surface of the rail in attempting to slide past the metal that is below the surface gives rise to high shear stresses. The compressive stress at any point rises from zero to a maximum and falls again to zero giving all conditions required for fatigue failure. Thus, just below the running surface, at the plane of maximum shear stress due to wheelrail contact, horizontal fatigue cracks may develop when the compressive stress exceeds the compressive fatigue limit of steel under repeated load. In addition to static wheel loads on the tread stress, impact forces like hammer blow which increase with speed add to the stresses due to static loading. Such cracks due to repeated shearing stress start inside the railhead as horizontal cracks and spread to the side of the railhead. Since the metal is not tied in place to the under-lying metal, the top surface is free to slide over the bottom. The metal above the crack is subjected to and shows a greater amount of cold work than the metal just below the crack. The increased lateral flow in the metal above a shelled spot results in depressions or dished out areas which is not kept bright by contact with wheel tread. They appear as dark spots on the gauge corner of rail. These internal cracks may then proceed upward or downward at one or both ends and develop as transverse fracture before reaching the rail surface which are as dangerous as transverse fissures. The break-down of the tread metal under heavy loads is known as shelling. The lesser the diameter of the wheel, the smaller is the area of contact between wheel and rail and the higher the stress for a given wheel load. It has been stated that the static load (tons)/wheel diameter ratio in excess of about : 2 is not desirable.

Another type of shelling originates as head checks on or near the upper gauge corner of the rail head due to concentrated loading and consequent cold working of the steel. Starting at right angles to the running surface on the gauge side of head or at fillet under the head, it spreads transversely through the head as a progressive fracture in crescent shaped rings round the point of origin. It is dangerous because it tends to occur at several places and may result in a complete brake of rail due to stresses on the gauge at short curves.

Sometimes, metal also flakes even on the more ductile materials when the shear stresses set up by the movement of the elastic wave ahead of the contact area between the curved surface exceed the shear strength of the material. This type of surface fracture on the more ductile materials is sometimes referred to as 'spalling' and it is not caused by fatigue. To minimise this, a suitable running in period under increasing loads is required to cold work the surface and enhance its physical properties.

Rails are also damaged and require replacements as a result of thermal cracks due to intense frictional heat on a rail surface from slipping locomotive driving wheels whenever locomotives on starting are not able to exert sufficient pull to move the train instantaneously. Subsequent rapid cooling results in a brittle

layer of hard martensite. As the rails bend under traffic, cracks are formed over this wheel-burnt area resulting in chipping of metal and roughening of surface under repeated traffic. Burned rail is potentially dangerous since transverse separation may develop at any time from thermal cracks.

The rail should not only be able to stand the high crushing stresses developed in the tiny surfaces in contact with the wheel but it should also have stiffness or resistance to bending; otherwise, the depression due to a loaded wheel will offer resistance to the movement of wheels increasing train resistance and wasting power in dragging the wheel continually out of such depressions. The former can be secured by suitable composition and heat treatment while the latter can be achieved by increasing the cross section and hence using heavier rails.

Rail weight is essentially a question of economics. About 30 years ago 75 lb. rails were in general use in India. By using 90 lb. rails both experience and tests have indicated that an axle load up to 22½ tons can be borne with economic advantages. The axle load of the W. P. engine has been limited to 18.5 tons so that it could be used over wide areas without the necessity of relaying with new and heavier rails.

In the beginning when wrought iron was used for rails, there was a tendency to laminate or split in the head before much wear had taken place. Rails were, therefore, rolled of a symmetrical dumb bell section, termed double head. When the upper head became defective, the rail was reversed and used again. At first, steel rails were rolled of similar section, so that when worn, they could be turned and used. As the new head usually suffered corrosion, ball head rails were introduced where the head was increased to allow of the full wear without reversal. This was, however, possible only in slow speed lines. With the introduction of fast traffic, relaying became necessary before the limiting wear was attained due to damage to rail ends. To reduce eccentricity of concentrated loads, rail heads are being redesigned to make a better fit between it and the worn car treads. They are being so shaped as to stimulate the outline of a rail worn in service from the contours of passing wheels.

To obtain economies in maintenance, the flat bottom section was introduced which had greater vertical and lateral stiffness. The wide foot gives greater resistance to bending in horizontal plane and increased strength in vertical plane. Consequently, it will preserve its line and top for a longer period.

From the point of view of economics, wear resistance is equally important. According to Dearden, British Railways purchase annually about 220,000 tons of rails costing about 6,500,00 £ to replace rails worn in service. Wear resistance is however a complex property representing the weighted average of a group of separate properties which are also influenced by environment.

The harder the steel the better will be the wearing quality and resistance to shelling. The usual method of increasing hardness is by increasing the carbon content. To get longer life under heavy loads, high speeds and frequency of trains, America is using 91—120 lb. rails made of steel having 0.6—0.8% carbon, 0.7—1% manganese, 0.1—0.23% silicon and 0.04 (max.) phosphorus. The physical properties as rolled are 140,000 tensile, 85,000 yield, 9% elongation, 300 brinell and an izod value of only about 2 ft. lb. Such high carbon rails, however, give rise to thermal cracks in service and shatter cracks in the interior of rail heads during manufacture leading to transverse fractures. Far from giving increased wear resistance, they were actually found to have the opposite effect of reducing rail life by producing a structure in the railhead which tended to powder away under heavy traffic.

The strength and ductility can be improved by quenching and tempering when a tensile of 165,000, a yield of 125,000, a brinell of 300 and an elongation of 14% have been obtained. As it is only necessary to harden the railhead to a small depth and immersion of the whole rail is either inconvenient or likely to result in warping, momentary quenching of surface has been applied. In the sand-berg process, a definite amount of water as fine mist is sprayed on the railhead. It is then transferred to a slow cooling chamber so that the surface, if martensite, is immediately tempered to give fine pearlite or sorbite.

Steels made up largely of sorbite are homogeneous and have higher tensile strength and elastic limit though ductility is less. Such a homogeneous material stands wear better than pearlite and will last longer. The nearest approach to a rail of increased life at a relatively small additional cost is the sorbite rail. But the development of an irregular form of hardening in the running surface—a type of corrugation due to hardening of the surface and its consequent low elongation resulted in very noisy running of trains. This has caused its virtual abandonment though the Germans use mobile plants for grinding out these corrugations in situ. The use of alloy steels when used simply in the 'as rolled' condition while offering little or no advantage over straight carbon steels

produce difficulties in welding. Manganese steel of the Hadfield type though having exceptional wear resistance and is useful for points and crossings is too costly for use as ordinary rail.

It will be seen from the above that in service the life of a rail is dependent on a number of factors. The abrasive action of tyres depends on axle load and speed. With high speed, the rail between the supports of sleepers has not time to regain its original position between the passage of each wheel and hardly between that of each carriage so that the weight of the whole traffic or at least that of the whole engine acts like one single blow on the rail. Though, with slow speed, the weight per axle may be taken into account, when running at high speed, the total weight of engine has to be considered. Due to the unbalanced part of engine, rails are also subject to the pounding action of the driving wheels. Skidding produces tensile stresses. The rail head in a hardened state by work hardening or quenching is unable to stand such stretching. In practice, a rail requires to be changed not so much on account of the wear on its head but due to the much greater wear at its ends. This wear is primarily due to the blow which the end of a rail receives when a wheel jumps the gap between the rail ends.

To reduce track maintenance expenses, a quality of rail is required that will afford not only longer life from the point of view of wear but also greater security from fracture. High carbon rails while giving the necessary strength are more susceptible to transverse fissures since the cementite (carbide) walls obstructs the escape of atomic hydrogen from the metal. Further carbon alone gives a hardness that powders away under traffic. Wear is a complicated phenomenon representing the weight average of a number of factors connected not only with the metal but also service conditions and the corrosive nature of the environment. Even with regard to metal, hardness is not the only factor. Since wear involves tearing of small particles of metal, toughness is also important. This is equally so from the point of view of resistance to shock where a low carbon will be an advantage. Thus a balance has to be struck between a low carbon steel which yields or wears quickly and a hard rail susceptible to thermal cracks or transverse fissures.

Trains in America are operating at schedules averaging 70 miles per hour for long distances to maintain which long sustained speeds over 100 miles per hour are frequently necessary. To cope with increased loads and speeds, rails weighing 90 lbs. and lighter have been found to be unsuitable. It has also been computed that on a well maintained track, rails have to be renewed as a result of wear when roughly 200 million tons of load have passed over a 90 lb. rail. With 152 lb. rails, the corresponding figure is 550 million tons. Further, stiffness on which depends the reformation of track in all directions increases very quickly with the weight of rail resulting in less track maintenance expenses. The stiffness is specially noteworthy in the vertical direction where it gives improvement at joints. The amplitude of the verticab wave motion is also reduced, thereby minimising tapping of sleepers. According to the French National Railways, the maintenance cost of track laid with 62 kg/metre rail are nearly half those of a track laid with 42/Kg/metre standard rail.

On the other hand, a heavy rail is expensive. Its microstructure is also coarse since less work is done on it during rolling. For years it had been known that the light rails rolled years back were better. When the railways made the rails heavier these did not give the anticipated service as they were of necessity finished at a much higher temperature. The inferior wearing quality of rails at high temperatures was traced to the coarse structure. As early as 1868, the Russian Professor Tschernoff showed that steel allowed to cool and grow undisturbed from a high temperature gives a coarse structure. The formation of large crystals is however prevented if steel is worked by rolling or forging to a low temperature like 700 C. The crystals will be smaller, the lower the finishing temperature of the final pass through the rolls and the greater the mechanical work done on the ingot by increasing the number of passes with less reduction per pass. In view of the above, a compromise is necessary. In England, with the occurrence of a few rail failures since 1932 when trains were timed to run at 60 miles per hour from start to stop, stiffer rails of the flat bottom type weighing 109 lb. yd. were adopted as the main line standard

It was also found that by raising the manganese from 0.68% to 0.98%, greater wear resistance was obtained than by raising the carbon from 0.52 to 0.62%. Manganese not only provided the desired combination of hardness to resist compression due to heavy axle loads and toughness necessary for wear resistance but also resulted in more freedom from rolling defects with less risk of transverse fissures. In 1932 basic Bessemer rails with carbon 0.45% and manganese 1% had to be purchased from Luxemburg since the cost of British open hearth basic rails having carbon 0.6% and manganese 0.75% was very high. Experience with these showed that the 30% higher manganese of the Belgian rails gave better resistance than the 30% increase in the carbon of the British rails. Further, the lower carbon permitted some increase in the phosphorus content which not only reduced the cost of production by decreasing the time of working in the furnace but also gave additional wear resistance.

The optimum requirements are maximum elastic limit combined with maximum elongation. Since the surface of rail is subject to elongation, if this is low, powdering, chipping or flaking will be the result. By increasing the carbon content, brittleness also increases. It is possible to combine considerable surface hardness with great toughness and considerable ductility in the body of the rail by heat treating a steel of medium carbon content. This is not only expensive but may also lead to cracking during quenching of steels having internal defects.

In the United States, the average axle load is about 2 tons higher while the locomotive coupled axles are about 50% heavier. Consequently, high carbon rails are used. In England and Europe where axle loads are less, rails with only 0.45—0.55% carbon are employed. The increased wear resistance is obtained by a higher manganese content (above 0.9%). Such low carbon steels would be tougher and hence safer and more economical as will be seen from the following results :

	basic open hearth (0.6% carbon & 0.75% manganese)	basic bessemer 0.45% carbon & 1% manganese
Tensile strength in t. s. i.	51	44
% Elongation	18	25
Reduction of Area	23	39
Impact value in ft. lbs.	6.5	14.5

The above shows that for an increase of 7 tons in tensile, toughness has to be sacrificed together with ductility as shown by elongation and reduction of area.

In spite of their very low Izod impact value of 2 to 4 foot-lb., steel rails are generally well able to survive the repeated impacts they receive at joints and crossings. This may be because rail steel is not brittle in the absence of a notch, since an unnotched Izod specimen will absorb the full 120 foot-lb. by bending without breaking. However, rail failures usually have their origin in some kind of crack or flaw which may be a manufacturing defect, a fatigue flaw, or a crack caused by the slipping or sliding of wheels. Any of these is equivalent to a notch and is likely to cause sudden fracture if present in a region of high tensile stress. It is, therefore, desirable to increase the toughness of rail steel.

While American and Indian specifications only refer to chemical composition, the French Standards have given more importance to physical tests, such as hardness, tensile strength and macrographic inspection for segregations. It may be noted that Ingots of the size used for rails (2 ft. square by 7 ft. height) require considerable time to solidify to the centre and hence give rise to chemical segregation which has been a prolific source of failures. Chemical analysis is only for purposes of information. The German specifications, however, do not state any chemical analysis, since it is considered that what is important is mechanical requirements. The means by which they are attained have been left to the discretion of the supplier. The British Standards have laid down a minimum tensile strength and elongation figures in case such test results are required. In view of this, there is a proposal to include in the relevent I. R. S. specification tensile tests requiring a minimum of 44 t. s. i. for medium manganese and 46 t. s. i. for carbon rails, with a minimum elongation of 11% on the lines of B. S. 11. To secure a fine structure through adequate mechanical work, a minimum ratio of ingot section to that of the finished rail has also been recommended.

(To be continued)

MINERALS IN CEYLON

According to a report, the Government of Ceylon has approved the setting up of a national Ilmenite Corporation with an initial capital of Rs. 8,000,000. The total annual income expected from this project is Rs. 4,419,000. The Ministry of Industries there, is reported to have decided to undertake the refining of high-grade monazite and rutile. The Ministry will shortly purchase a magnetic separator for this purpose, which will be installed at its refining plant at Kalutara, South of Colombo, on the west coast. The Department of Mineralogy is already refining a lower quality of monazite from sands at Beruwela.

APPLICATION OF THE ELECTROSTATIC FLOCKING METHOD FOR THE PRODUCTION OF A VELVET-VELOURS FINISH BY MEANS OF A FLOCKING CARRIAGE

By Director of Publicity,
Arno H. Wirth, Reutlingen, Western Germany

THE purpose and value of the electrostatic flocking method is that by means of electrostatic fields, precise-cut rayon flocks of appr. 0.5 and 1 mm. staple length, can be applied to a basic material, so that the surface presents a velvet or suede-like material. In this way a cheap and attractive refined material is obtained.

The process itself can no longer be regarded as new. At first, it was thought that this method would probably have a "short life", until it was discovered that the resultant advantages, viz. the attractiveness and above all, the economical aspect, made an industrial exploitation very worthwhile. Nowadays, on the textile sector in particular, the refinement and action of the electrostatic flocking method is becoming more and more accepted as a necessity.

But also in other industries, favourable application possibilities are given, with the result of extensive business transactions of German firms in refined flocked goods. Following are some examples :

Wood :	flocking of cutlery boxes, inlaid boards for show cases, boxes and cases of all kinds, toys, decorations, bobbins,
Paper :	flocking of cardboard, wall papers, calendar backs, carnival articles, appliances for teaching, greeting cards,
Glass :	flocking of thermometers (back), fine art articles,
Plastics :	flocking of crepe rubber sheets, foam rubber cushions, P. V. C., polystyrol, bakelite, display articles, telephone mats,
Leather :	flocking of skins, cases for cameras, optical instruments, slippers,
Textiles :	flocking of continuous material, uniform or design (flockprint cocktail and evening dresses), lastex belts, scarfs, jumpers, gloves,
Metal :	flocking of sheet metal boxes, linings, record plates,
Jewellery :	flocking of broaches, powder-boxes, and all products of the Gablonz jewellery industry,
Interior Decoration :	flocking of shop windows, fair stalls, cinemas, coffee houses and bars, decoration of representative halls,
Acoustics :	inside flocking of housings to reduce unwanted noise, natural vibrations, and to increase sound absorption.
Lighting :	flocking of reflectors (outside), lamp shades, table lamp bases.
Office Equipment :	flocking of book-keeping plates, versatile office equipment.

Our business connections in Germany and abroad are always requesting our latest publications on new constructions in the sector of the various electrostatic flocking methods, as well as their most profitable employment and use in practice.

We are glad to agree with these requests as there is still very little knowledge about this special subject and only a limited literature on hand.

As a result of this, there has arisen the necessity of giving the greatest possible assistance to clients concerning the introduction of the process, also to help clients over their first difficulties and to give every assistance to remove the cause of faults coming from the technical ignorance of the workers using these new machines. The responsible manufacturer is therefore required to make his constructions as simple as possible, so that even unskilled workers may set the machines into operation according to the working instructions.

For overseas as well as continental customers, the opportunity of requesting our machines is considerably helped by knowing that "their" workers can handle the machine, and that losses of production may be avoided.

Today, we intend only to discuss the flocking carriage, the purpose of which is to flock the goods and larger surfaces, e. g. hardboard, skins, etc. which are already prepared with adhesives for decorative flocking, and placed on screen printing tables.

The construction of our *FLOCK CARRIAGE Model "57"* meets completely the requirements of the most varied demands. Correct attendance is assured by a very simple mechanism which eliminates human insufficiency to a degree not previously attained.

The most important characteristics are :

(1) Easy and controlled handling.
(2) Close and solid flocking.
(3) Extremely high capacity of the suction electrode.
(4) Separated sources of high tension for the flock and suction electrodes.
(5) Avoidance of conglomerations of flocks.
(6) Separated and controlled regulation of the driving gears.
(7) Stepless dosing of the flock feeding.
(8) Relatively high flocking speed.
(9) Simple dismantling of the flock carriage without screws, within a few minutes, in order to realize the cleaning in case changing of the flocks is required.

In order to produce the necessary high tension, the Electrostat was invented. In contrast to the former types of our flock carriages, our latest model "57" disposes of two high tension sources, as it is more advantageous to supply the flocking and suction electrodes separately with D. C.

Between the high tension flock electrode (4) and the flocking goods, the high tension fields are formed. The flocks leave the high tension potential, are adjusted and enter vertically into the goods covered with adhesive.

The flocks in the hopper are forwarded into the flock feeding device by means of a conveyor belt which can be regulated (10). Thereby, the required flocks are regulated by a dosing-ductor (9) into a rough adjustment, while the fine adjustment is done by a conveyor belt, steplessly regulated. The flocks are forwarded to the flock-electrode (4) by means of a brushing-system (6). The flock electrode has to work first as suction electrode. A second suction electrode (11) takes up the surplus flocks and these flocks are impelled underneath the conveyor belt (10), detained and returned without waste into the hopper (8).

The Unit can be put immediately into operation after the correct dosing of the flocks has been determined. There is no danger of any kind for the attendant as the intensity of current required is only up to 1 mA. Moreover, all high tension conducting parts are protected against any unintentional touch.

AWR ELECTROSTATS TYPES S 3, S 4, S 5

The herein described electrostats are working with the different necessary flocking installations, as following :

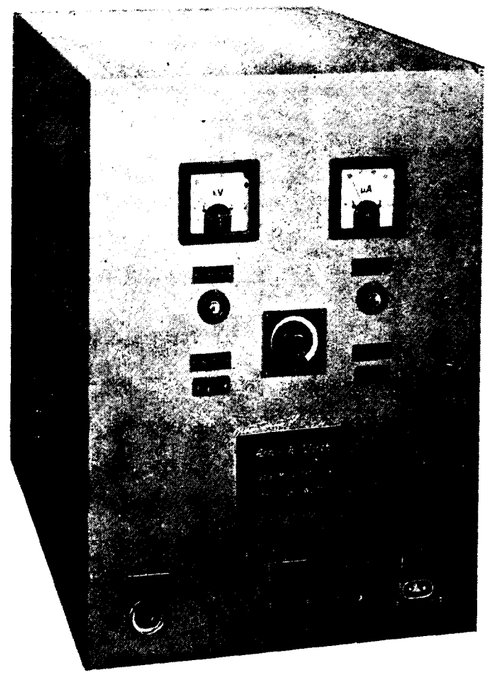


Fig. 1. AWR–Electrostat S 3 & S 4.

S 3 for industrial use for flocking of single workpieces of all descriptions in batches, serving one or several work places, suitable also for narrow fabrics flocking plants.

High tension: 60000 Volt D. C.

S 4 for industrial use for flocking plants in continuous lengths and electrostatic detearing of lacquers.

High tension: 80000 Volt D. C.

S 5 for industrial use, especially designed for high capacities for flocking in continuous lengths and for the production of abrasive papers.

High tension: 100000 Volt D. C.

DESCRIPTION

All the units are corresponding to the VDE prescriptions. The capacity of the units is so large so that in case of network undervoltage up to 10%, there are sufficient reserves to guarantee a flocking process without troubles.

By reason of security and for guaranteeing a continuous working process, the high tensioned D. C. will be produced by condensors in connection with selenic rectifiers.

All materials used are of highest insulating quality. The electrostats are perfectly proof against moist air and dust. Standard execution for 220 V. A. C. 50 cycles. Supply for other tension possible without any additional charge. They are provided with two measuring instruments to control the outgoing high tension (kV-meter) and the D. C. (ampere-Meter). The high tension can be adjusted by a high tension regulator giving stepless adjustment. There are also signal lamps for earth and high tension control, mains supply connection, earth socket and fuse equipped for 1 amp.

Guarantee: 6 months in agreement with the VDE prescriptions.

Technical data:

	S 3 and S 4	*S 5*
length:	500 mm.	500 mm.
width:	350 mm.	350 mm.
height:	500 mm.	600 mm.
Tension:	220 V	220 V
Power consumption:	approx. 100 Watt	approx. 100 Watt
Weight:	approx. 38 kg.	approx. 42 kg.

Cutting Machine

The special cutting machine for Rayon Monofilament Tow is a unit which has proved its value during many years of troublefree and uninterrupted operation. All rayon flocks without exception which are supplied by us are exclusively cut on this machine.

Technical data

	Type 60/1	*Type 80/11*
Output	appr. 30 kgs./hour (at 1 mm. length)	appr. 45 kgs. hour
Height	1410 mm. (complete machine)	1260 mm.
Width	630 mm. ,, ,,	690 mm.
Length	1100 mm. ,, ,,	1100 mm.
Weight	appr. 240 kgs. ,, ,,	appr. 310 kgs.
Power required for lengths of flock upto 1,5 mm.	1 HP. 1400 revs./min.	1¾ HP. 1400 revs. min.

In case flock lengths from 2 mm. upwards are required a pole changing motor with a second speed of

0,6 HP. 700 revs. min. 1,2 HP. 700 revs. min.

is required. The electrical equipment has to be supplied by the customer.

Cutting lengths from 0,5 3,5 mm. in steps of 0,5 mm. can be obtained. A change wheel for a cutting length of 0,35 mm. as well as 2 cutting knives are included. On request each machine can be arranged for other cutting lengths, i. e. 0,3 mm, 1 mm., 2 mm., 2,8 mm. etc.

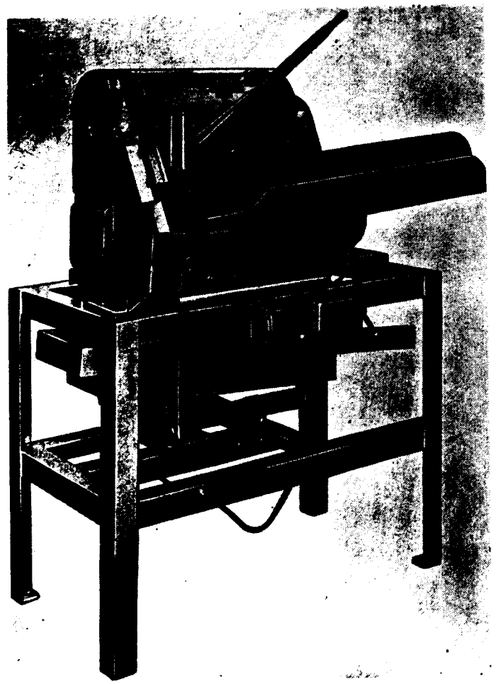


Fig. 2. AWR-Flock Cutting Machine.

The life of the blades between re-grinds is entirely dependent upon the quality of the material to be cut. The blades can be exchanged within 10—15 secs.

The cut is a guillotine cut with appr. 340 strokes p. m. All cutting machines are supplied with a presieving attachment but *without* the necessary motor (power required 0,27 HP. 1400 revs./min.) On request the machine is supplied *with* motors and electric installation, ready for operation. In this case informations as to the current available are needed.

To obtain flocks ready for flocking, the a/m described machine is not sufficient, since in view of the high pressure during the cutting process there are conglomerations of flocks and small quantity of over and under lengths. These have to be separated and sieved again after the cutting process and for these purposes we are recommending for a larger output the following additional equipments.

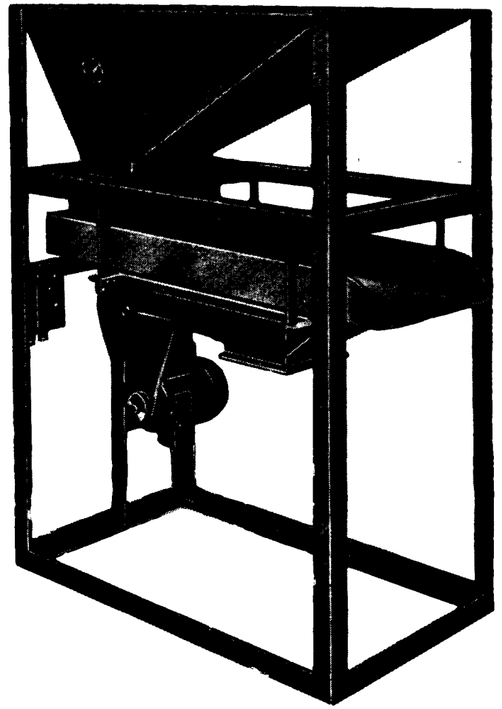


Fig. 3. Flock Sieving Machine.

Flock Sieving Machine
Flock Separating machine
Special Grinding Machine

AWR FLOCKING CARRIAGE MODEL "57"

Purpose:

1. Decorative flocking (flock print) in long lengths by means of electrostatic fields, on screen printing tables. Designed for the production of velvet and velours effects.

2. Decorative or full flocking of sheets (bath mats, all kinds of sheets, skins, etc.)

3. Continuous production of velvet and velours surfaces on running meters (paper, textiles, PVC, etc.) It is possible to work with 2 or more stationary aggregates.

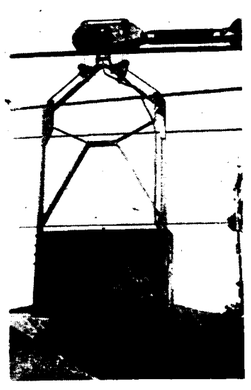
Aerial Ropeways & their Important Role in Industry

By William Gillmore
British Ropeway Engineering Co., Ltd., London

AERIAL Ropeways are playing an increasing part in the industrial life of this country and of many other countries throughout the World. There is a continuous and expanding demand for mechanical handling of materials to minimise expensive labour costs, and this has a large influence in the design and supply of Aerial Ropeways.

After the initial capital outlay, ropeways provide probably the cheapest mechanical form of transport in the World, and there are many instances where the power employed is actually nil, and sometimes the force generated by the buckets going down the line involves the problem of the disposal of surplus power.

The ropeway has long been accepted as the ideal form of transport over rough and hilly country where the cost of any other form of transportation would be excessive. In this country, where it is unusual to



meet very severe site conditions, the full possibilities of Aerial Ropeways are often not fully appreciated, and it is hoped that these comments may enlighten the reader as to their suitability.

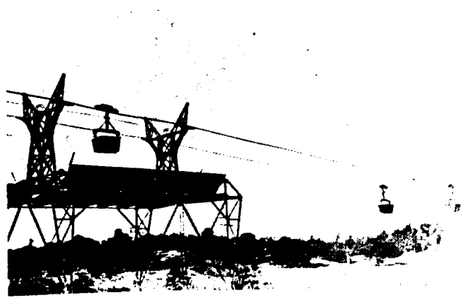
There are two common systems known as monocable and bicable ropeways. The first employs a single endless rope which both supports and transports the load. The bicable employs two ropes, one of a comparatively heavy capacity which is motionless and acts as a rail to support the moving bucket which travels along it on wheels, and is pulled by a smaller flexible rope, termed the hauling rope.

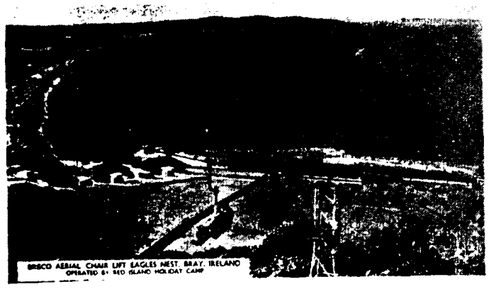
In general, the monocable is cheaper to instal but, of course, the rope wear is much higher and greater manual operation is required. In the case of the monocable ropeway, the mechanism on which the load is carried, named the boxhead, is lifted from the rope at the terminal stations and transferred to a shunt rail where the bucket is normally pushed by hand or gravity round the terminal before embarking on its return journey.

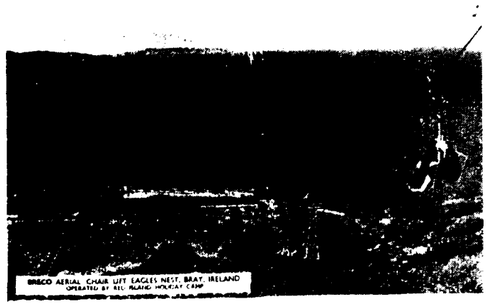
The bicable ropeway has an automatic locking and unlocking device in the stations to enable the hauling rope to be unclipped from the carriage when entering or leaving the stations. The bicable has lent itself to considerable mechanisation in that the bucket can be carried round the stations without

manual assistance, by means of a chain haulage device. The buckets which have discharged their load enroute can be either self-righting or righted in the stations and, to change the direction of the line in the horizontal plane, an angle station can be inserted which again, can be run entirely automatically.

In addition to the general description of single rope and bicable installations, we can consider these further







divisions. The monocable, can be merely a gravity shoot or a fixed clip ropeway. The gravity shoot is the simplest form of Aerial Ropeway ever devised, and is largely used in Tea Gardens in India. A single rope is fixed over a valley with a suitable fall between its two ends, a single wheeled carrier is suspended from the rope and is placed at the upper terminal and travels to the lower by gravity. There is, of course, no method of speed control of the load in transit, and there is no means of returning the empty carrier to the top point except manually.

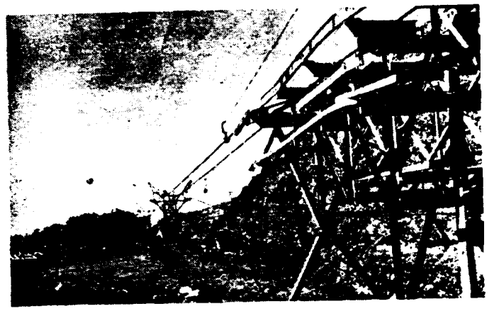
The fixed clip ropeway consists of a single endless rope passing round a driving sheave at one terminal and an idler at the other. Spring steel clips are firmly fixed to the endless moving rope at regular distances and, from these clips, are suspended hangers to carry the load. Such an installation demands the use of labour to load and unload at suitable points but, unlike the simple gravity shoot, it does not rely on gravity for the source of power and the empty carriers are returned to the loading point.

Just as the monocable system has the simple types of installation referred to above in gravity shoots and fixed clips, so the bicable system has its simplified forms in single and double jig backs. The single jig back employs a fully tensioned fixed track rope on which the carrier runs, the speed of the carriage along its rope is controlled by using a separate endless haulage rope, but only one carrier is employed and, of course, the capacity of the line varies inversely as the length increases.

The double jig back ropeway is a refinement on the single installation, as a second track rope is added and, by this means, the loaded car can be pulled up while the empty car is descending, similar to a balance funicular railway.

In the above short description of the various types of ropeways employed, no reference has been made to passenger carrying ropeways which are refinements on the normal commercial installations. Where human lives are concerned, it is necessary to ensure that rigid safety standards are maintained and whilst, basically, there is little difference between a passenger and goods carrying ropeway, it is essential to provide additional safety cables for the full protection of the passengers should any unforeseen defect occur.

As a specialised form of installation in the fields of Winter Sports, ski-lifts are now being supplied to convey ski-ers from the foot of the ski-run to the top in an effortless manner. These small installations are



Loading Station.

modifications on the fixed clip monocable ropeway and generally have a single endless moving rope to which clips are permanently affixed, a tow-bar is suspended from this clip and the ski-er grasps this tow-bar and is pulled up the ascent.

An interesting recent development is an Aerial Ropeway Transporter which has been supplied to the Iraq Petroleum Company at Al-Fatha in Iraq. The Petroleum Company built a new pipe line which involved the conveyance of a lorry loaded with sections of pipe, 30 ft. and 60 ft. in length, across the River Tigris. In addition to being of sufficient capacity to handle these great lengths of pipe, general transport associated with the maintenance and equipment of an oil pipe line construction had to cross the Tigris. The load car has a deck space of 50 ft. by 10 ft. Cars and lorries, up to a maximum load of 23½ tons, can be transported across the river by this modern installation which has many refinements.

POSTAL FACILITIES FOR STEEL PROJECT

It is reported that the postal authorities in India have finalised a two-years' plan for the development and extension of posts and telegraph facilities for catering to the needs of the Bhillai steel project. The plan includes the opening of a big first class post office and a telegraph office in the centre of the township with a number of non-delivery offices; to open separate telephone exchanges at the steel project having 1,500 telephones; to establish telephonic link between the Bhillai Steel Project and the surrounding iron ore and dolomite mines; and to arrange availability of early trunk calls between Bhillai and Calcutta, Delhi and Visakhapatnam. The implementation of the plan will start soon.

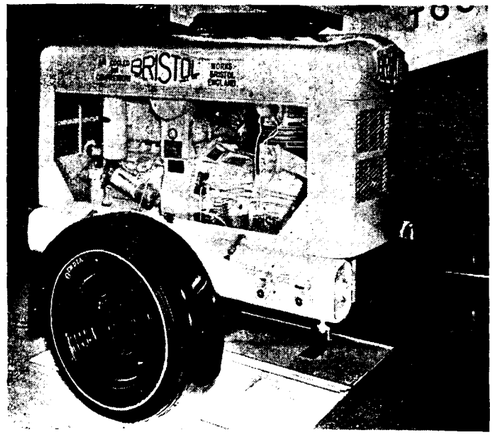
Armstrong Siddeley Diesel Engines

By Plant Engineer
Armstrong Siddeley Motors Ltd., Coventry

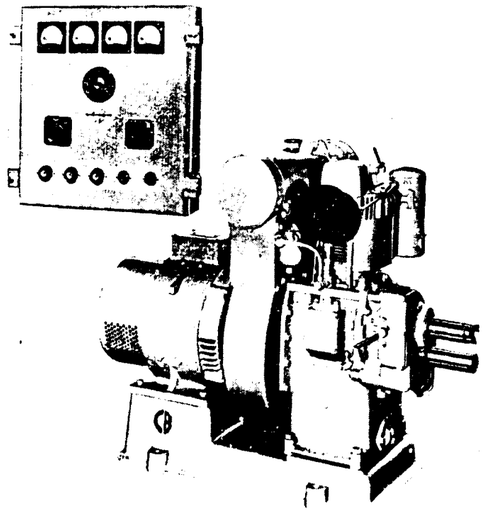
ARMSTRONG Siddeley Motors of Coventry, England, have been building high grade cars since the beginning of the Century and aero engines for almost as long. Armstrong Siddeley air-cooled radial engines have been well known for over 30 years. With the advent of the gas turbine the Company's Sapphire engine soon became well known. It is one of the most powerful of its type in the world. It powers in its various forms over 12 different aircraft including the Hawker Hunter and over 6 types of aircraft in the United States where it is known as the Wright J 65

With this wealth of experience in precision engineering and air-cooling it is not surprising that when the Company put upon the market an air-cooled Diesel Engine in 1946 it at once commanded respect.

The current range of Armstrong Siddeley Air-Cooled Diesel Engines includes Single, Twin and Three Cylinder models developing 6/11 bhp., 14/22 bhp., 20/33 bhp. respectively. A complete range of equipment is also built including Clutches, Clutches and Reduction Gears, Power Take-Off, Electric Starting, Slow Running and Variable Speed Controls etc.



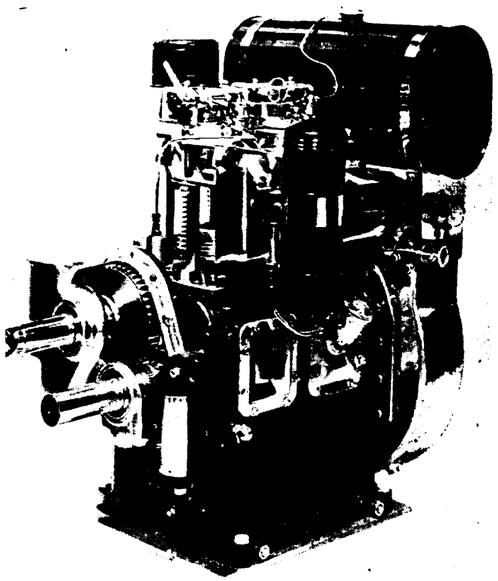
'Bristol' Portable Compressor Powered by an Armstrong Siddeley Twin Cylinder Diesel Engine.



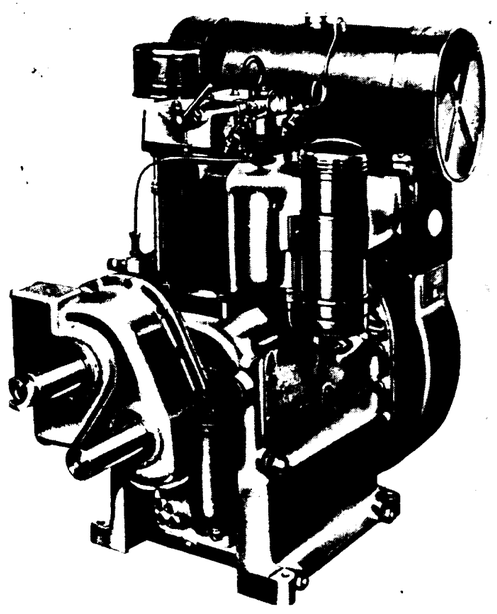
'Clarke-Built' Generating set 6 KVA Powered by Armstrong Siddeley Single Cylinder Diesel Engine.

The advantages of air-cooling in the elimination of the risk of cracked and broken cylinders, water jackets, tanks and radiators due to frost, and cooling troubles caused by dirty water are obvious. The Armstrong Siddeley system of air-cooling makes use of a vaned flywheel and ducting to the finned cylinders and heads, and this method enables a very precise control of the engine temperature to be maintained. The engines will operate satisfactorily in any temperature. Engines are working under Artic conditions and in the heat of the Tropics. Some are driving Water and Air Pumps at the bottom of Pit Shafts in the Belgium Congo, where operating conditions are as adverse as can be found anywhere in the World. Air-cooling and the compact and self-contained nature of the engines makes it possible to install them almost anywhere.

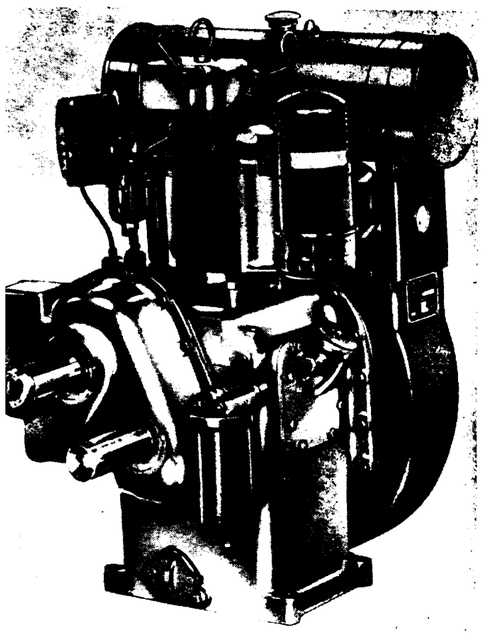
The engines operate between 1,000 RPM and 1,800 RPM and are used for driving an immense variety of Industrial and Agricultural apparatus.

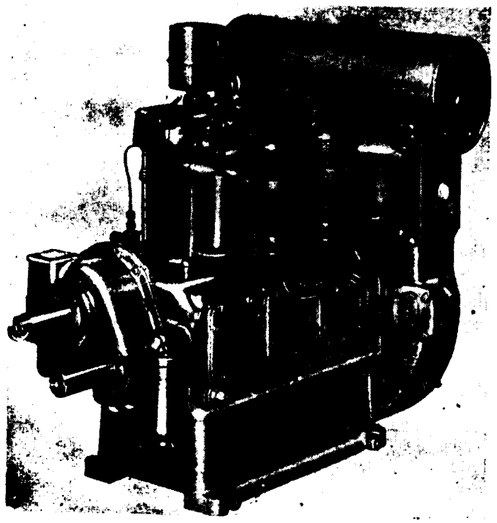


Armstrong Siddeley Sectioned Twin Cylinder Diesel Engine.



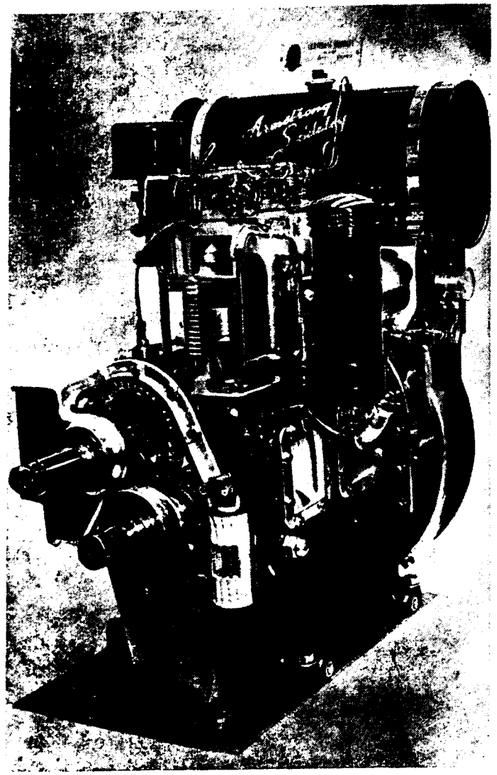
Armstrong Siddeley Twin Cylinder Diesel Engine.





Top: Armstrong Siddeley Three Cylinder Diesel Engine.

Left: Armstrong Siddeley Single Cylinder Diesel Engine.



Armstrong Siddeley Sectioned Twin Cylinder Diesel Engine.

Many well known firms list the engines as standard equipment on machines ranging from Pick-Up Balers to Compressor Sets, Welding Sets, Generators etc. In many cases the engines have been adapted to replace the older petrol driven units.

The engines are extremely robust and all the models incorporate many parts which are interchangeable. This is a big advantage in servicing the engines.

The general advantages of the Diesel Engine are well known and include the important ones of long life between overhaul periods and great reliability. The greater efficiency of the diesel engine is reflected in the economy of fuel consumption and the elimination of fire risks.

The three Armstrong Siddeley engines have many features in common with each other. A brief specification follows:

Totally enclosed vertical air cooled four cycle direct injection compression ignition engines specially designed for industrial and agricultural purposes.

VALVE GEAR: Totally enclosed and pressure lubricated, the valves operated by push rods and rocker levers.

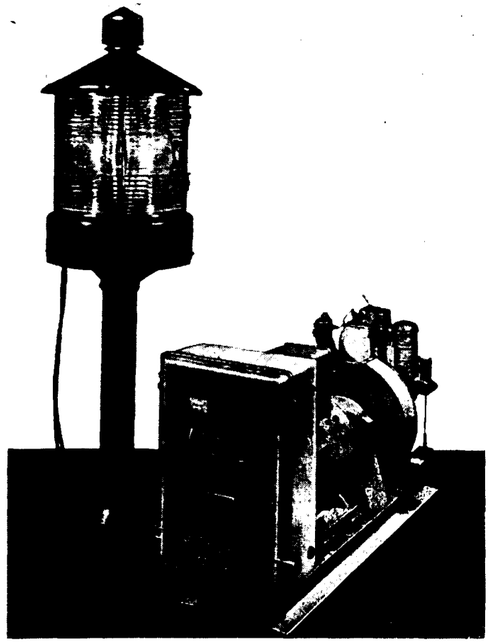
GOVERNING: A centrifugal bob-weight type governor mounted on the camshaft gear controls the engine speeds to comply with BSS 649—1949 limits, and incorporates and automatic overload stop.

FUEL SYSTEM: The standard fuel tank incorporates a sediment trap and drain plug. Gravity feed through a large capacity fuel filter. C A V injection equipment with individual pumps.

LUBRICATION SYSTEM: A rotary pump draws oil through a strainer in the crankcase and delivers through a full flow Tecalemit filter. The crankshaft, connecting rod big end bearings, the camshaft bearings and rocker gear are pressure lubricated. Cylinder bore, gudgeon pin, tappets etc. are splash lubricated from the big end bearing.

AIR CLEANER: A Burgess oil washed type is fitted as standard Pre-cleaner type cleaners can be supplied.

Massey Harris Pick Up Baler Powered by Armstrong Siddeley Twin Cylinder Diesel Engine.



'Chance' Unattended Lighthouse Installation Powered by Armstrong Siddeley Single Cylinder Diesel Engine.

EXHAUST SILENCER: A pepper pot type silencer is fitted. Acoustic type silencers can be supplied.

STARTING: Easy starting by means of a decompressor and dog type starting handle operating on the camshaft. Electric starting equipment available.

POWER TAKE-OFF POINTS: Crankshaft at engine speed, camshaft at half engine speed and driving shaft or power take-off at engine speed where fitted. Pulleys up to 7 ins. diameter can be fitted to the crankshaft or camshaft extensions. If a pulley of greater diameter is to be used the engine may be ordered with either the crankshaft or camshaft extensions removed. Drives up to the full rated power can be taken from the camshaft on Single and Twin Cylinder Models, on the Three Cylinder Model indirect drives must not exceed 70% of the rated power.

The engines are supplied complete with fuel tanks, air cleaners, exhaust silencers, maintenance manual and spare parts list and are ready to operate once a suitable mounting has been provided.

A complete range of accessories are available and comprises the following items:

Single & Twin Cylinder	*Three Cylinder*
Starting Adaptor for Pulley Mounting 3" long	Starting Adaptor 3" long
Flywheel Driving Shaft 10" long	Flywheel Driving Shaft for direct drives only 10" long
Centrifugal Clutch	Power Take-off for use with indirect drives
Clutch and 2 : 1 Reduction Gear	Clutch and 2 : 1 Reduction Gear
Industrial Clutch	Industrial Clutch

All Models

Pulleys — Pre-type Air Cleaners

Acoustic Exhaust Silencer

Variable Speed and Slow Running Controls

Electrical Starting Equipment — Foundation Bolts

The engines are suitable for marine use and conversions are made by Parsons Engineering Company Limited, Southampton, England who have supplied many installations for uses in a variety of craft.

'Greens' Tandum Road Roller Powered by Armstrong Siddeley Three Cylinder Diesel Engine.

The engines are all extremely robust in construction which will be seen from the photograph of a sectioned engine and have been designed to operate for long periods with the minimum of attention. The crankcase is a single iron casting with large inspection doors at either side which gives easy access to the bearings etc. when this becomes necessary. The cylinder barrel and the head are iron castings, a flange on the cylinder being incorporated for bolting to the crankcase. The overhead valves are made from Silchrome steel and are operated via push rods in the usual way. The piston is a light alloy casting incorporating the combustion space in the piston crown. It is fitted with three compression rings and two slotted oil control rings, one of which is located below the gudgeon pin. The Connecting Rod is an 'H' section steel forging fitted with thin wall precision type bearings, the top half being indium lead bronze and the lower half white metal. The gudgeon pin bearing is a phosphor bronze bush pressed into position. The crankshaft is a high tensile steel forging machined all over to aircraft standards which is unusual in the engines of this type. The main bearings are white metal.

The camshaft is of hardened steel and protrudes at the front of the engine and forms an alternative driving point to give half engine speed. A starting dog is fitted at the end of the camshaft from which the engine is normally started.

The flywheel incorporates vanes which, by means of a cowling, direct a cooling blast of air to the cylinder.

The engine bearings are lubricated with oil under pressure from a gear type pump which is housed in the timing gear casing and driven from the crankshaft by spur gears. An external copper pipe conveys oil from the camshaft bearing to the overhead valve rocker gear, the oil returning to the sump through the push rod cover tubes thereby lubricating the tappet mechanism.

The fuel pumps and the fuel injectors are standard C A V units, the fuel pumps being driven through rockers from the camshaft. The delivery of the pump is controlled by a governor which may be adjusted to give any speed required between 1,000 and 1,800 RPM.

The photographs show just a few of the engines' different applications, concrete mixers, pumps, stone crushers, saw mills etc. are all driven successfully by the engine.

Armstrong Siddeley Motors will be pleased to give full details of the engines and any technical advice regarding particular applications.

Neutral Raw Wool Scouring

By R. A. Olney and B. A. Ryberg
Textile Research Department, The Procter & Gamble Co., Cincinnati, OHIO

INTRODUCTION

WOOL has traditionally been scoured under alkaline conditions for generation, despite the recognised dangers of yellowing, harshening, tensile strength loss and general chemical damage to the fibre due to its sensitivity to alkalies.

The desirability of scouring wool without the use of alkaline materials or, as it shall be referred to in this paper, neutral scouring, has been apparent to many textile technologists for at least twenty years.

In 1939, Elod and Rudolph (1) wrote: "The systematic investigation of the properties of wool protein and the mechanism of the common finishing procedures leads to the conclusion that these procedures should be redesigned to more fully take into account the properties of the wool protein in order to preserve to the fullest extent the valuable physical, and mechanical properties of the wool fibre". However, a substantial change in processing methods could not have been effected at that time due to the lack of suitable chemicals (from a price and availability standpoint) and because of the limitations imposed by equipment and/or technological know-how.

Prior to World War II, the most effective detergent available to the wool scourer at a reasonable cost, was soap. It was effective not only from the standpoint of its cleaning ability but also in the hand or feel it imparted to the fibre Soap, properly used, also imparts softness and pliability to the wool. These are important considerations not only for aesthetic reasons but also from the standpoint of subsequent processing. Harsh, overscoured wool will not card well, increases noilage, and combs and spins poorly, despite the use of fibre lubricants. It has long been known that the condition of the wool on leaving the dryer after scouring will greatly influence the quality of the finished product into which it is made.

Soap alone, however, cannot do the job properly or efficiently. If it were used alone, in a raw wool scouring bowl, for instance, soap would be subject to the following:

(1) Hydrolysis - which reduces the effectiveness of the soap

(2) Rapid exhaustion due to:

  (a) Contaminants and grease brought in by the wool.

  (b) The substantivity of soap to wool.

(3) Precipitation due to hard water and contaminants (calcium and magnesium salts etc.) brought in by the wool.

Certainly these difficulties could be overcome by the addition of more soap, but the amounts needed would make the cost of the operation prohibitive. In order to increase the efficiency of the soap and reduce the amount needed, an inexpensive builder is required. Sodium carbonate (soda ash) has long been used to meet these requirements. Its functions are to:

(1) Suppress hydrolysis of the soap.

(2) Saponify the fatty acids in the wool grease to produce more soap thus increasing the efficiency of the system.

(3) Aid in the emulsification of the grease.

(4) Partially reduce the detrimental effects of hard water and the contaminants brought in by the wool.

(5) Reduce the absorption of soap by the wool.

(6) Reduce the costs by increasing the efficiency of the soap through synergistic action.

Although alkali is beneficial to the action of the soap, it is detrimental to the wool. As previously mentioned, it yellows, harshens, and weakens the fibre. Residual alkali in the stock can cause many problems in carbonizing, carding, spinning, weaving, dyeing and finishing. These detrimental effects of alkali have been demonstrated repeatedly not only in the laboratory (1, 2) but also in actual practice. Thus, it appears logical that an effective and economical system of wool scouring in which the use of alkali is omitted would be useful.

Synthetic detergents have steadily decreased in price to the point where they have become economical for use in raw wool scouring.

A number of modifications of the soap and alkali scour have been proposed in the past and some of them

have been used for a number of years. Most of these *substitute* a synthetic anionic detergent for the soap, although in recent years nonionics have also been used.

The anionic syndets, particularly the alkyl sulfate and alkyl aryl sulfonate types, have a number of important advantages over soap:

(1) They do not hydrolyze under normal usage conditions.

(2) Their efficiency is less impaired by hard water than is soap.

(3) They are generally more soluable and more readily dispersed than soap.

(4) They are less sensitive to pH variation than soap.

These advantages and others, including better rinsability, lime soap dispersing ability, stability to rancidity, ease of handling etc. would appear to make it desirable to use anionic synthetic detergents in place of soap. It was found, however, that the use of an alkali was still required for economical processing and maximum efficiency (3-6). The main reasons for this were:

(1) Anionic synthetic detergents are generally more efficient under alkaline conditions.

(2) As with soap, the alkali saponifies the fatty acids of the wool, thus increasing the efficiency of the system.

(3) Anionic synthetic detergents exhibit much less substantivity for wool at higher pH's than they do under neutral or slightly acid conditions where they can be more substantive than soap.

(4) The alkali aids the detergent in emulsifying the grease.

It is also known that the effectiveness of an anionic detergent alkali system can be further improved by the addition of a salt such as sodium chloride or sodium sulfate (3).

The above syndet systems do not however, represent the most desirable departure from standard raw wool scouring procedures in that alkali still plays an indispensable part and because it has been found that anionic detergents in combination with alkali produce a much harsher fibre than soap and alkali. This latter disadvantage limited their use to those operations where fibre quality was secondary to processing efficiency. The situation is further complicated where a salt is used since this significantly increases the absorption of alkali by the wool.

Thus it appears that a detergent that does not require an alkali for optimum performance is required if an alkali free or neutral scouring system is to be effective. It seems reasonable to expect a member of the nonionic class of detergents to meet this requirement, particularly one of the alkylaryl poly-ethoxyenthanol type. Within certain molecular weight limits nonionics of this type are:

(1) Superior emulsifiers under neutral and even acid conditions.

(2) Non-hydrolizing.

(3) Non-substantive.

(4) Not adversely affected by hard water and calcium and magnesium salts.

(5) Effective over a wide pH range.

(6) Good lime soap dispersants.

(7) Economically priced.

In addition, they dissolve readily, are stable to rancidity and are free rinsing.

A number of workers have reported on the use of nonionics in the scouring of wool, both in raw stock and subsequent stages (3-8). In most instances, the nonionic is used merely as a substitute for soap, however, and alkali is still present in the system.

In only a few of the cases that have come to the attention of the authors is alkali omitted entirely and replaced by a neutral electrolyte as the builder (6, 7, 9). Of these only LaFleur (7) presents systematic laboratory data in support of his contentions. His work however, was carried out on woollen cloth soiled with a self-emulsifying mineral oil, and does not bear on the problem of removing the natural soil and grease from raw wool.

The apparent lack of published data clearly indicating the controlling factors of a neutral raw wool scouring system and their relative importance prompted this investigation. The work was carried out in two stages: Laboratory investigation and field tests.

LABORATORY WORK

The laboratory work reported here was carried out as a short term project aimed at determining the optimum conditions for a neutral raw wool scouring

Fig. 1 Laboratory three-bowl scouring apparatus.

system, using a nonionic detergent of the alkylaryl polyethoxyethanol type.

TEST METHOD

The AATCC Tentative Test Method 64—52 for the "Evaluation of Continuous Scouring of Raw Grease Wool" (described on pages 129—131 of the 1955 AATCC Year Book) was used in studying the effects of variables such as detergent and builder concentration, temperature, etc. on grease removing efficiency of the system. A number of minor modifications were introduced into the method; namely,

(1) Ten-gram skeins rather than five gram skeins of grease yarn were used.

(2) A separate squeeze roll was used for the skeins emerging from the scouring bowl in order to facilitate returning the squeeze liquor to that bowl.

(3) Residual grease determinations were made by means of ethyl ether extractions in the Soxhlet apparatus in place of the carbon tetrachloride-cup and plunger method.

(4) The residual grease content was based on the scoured, conditioned 20—30% relative humidity weight of the skein rather than the grease weight.

The apparatus used in this study is pictured in Figure 1 and comprises a three-bowl system. The power driven padder (lower right) was used on the skeins emerging from the suint and rinsing bowls (centre and right hand stainless steel beakers respectively) while the skein from the scouring (left hand beaker) was put through the hand wringer which returned the liquor squeezed from the skein to the bowl. The aluminium bottle (centre) fed a continuous supply of distilled water to the rinsing bowl which in turn overflowed into the desuinting bowl. The skeins were lowered into the bowls by allowing the horizontal rod from which the glass hooks are suspended to slide down. A reciprocal motion was then imparted to the immersed skeins by activating the long lever (far left). After thirty seconds, the skeins were lifted out of the bowls put through their respective squeeze rolls and passed on to the next bowl, or, in the case of the rinsed skeins, hung on the horizontal bar (upper right). Unless otherwise noted no addition of detergents or builder were made during a particular run.

The grease yarn used in preparing the skeins was obtained from Secretary of the AATCC. It was marked Wool Lot No. 2 and was found to have an average grease content of 4.2% on a grease weight basis.

TEST CONDITIONS

The preliminary work consisted of finding the most sensitive conditions of temperature and detergent concentration for the test method and then determining its reproducibility.

A number of scouring runs were made with several different detergents (both nonionic and anionic), which and without builder at different levels of temperature and active detergent concentration. The greatest differences in grease removal between detergents and detergent systems were obtained at a temperature of 165 F and a detergent concentration of 0.10% (on a solution weight basis).

A number of duplicate or check runs on various detergent and detergent-builder combinations indicated that the method had exceptionally good reproducibility. Check runs were made from time to time throughout the duration of the programme to assure operator procedure, and test specimen uniformity.

RESULTS AND DISCUSSION

Scouring efficiency as a Function of Nonionic Detergent Concentration. Grease removal efficiency as a function of detergent concentration was studied by making four runs at various levels of detergent concentration (no builder). The percentage figures labelling the curves in Figure 2 indicate the detergent concentration of the scouring bowl liquor.

As can be seen, the effect of detergent concentration is two-fold. As it is increased, 1) the residual

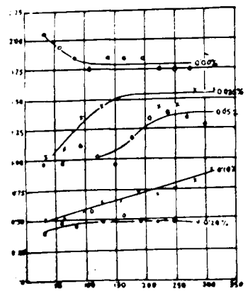


Fig. 2.

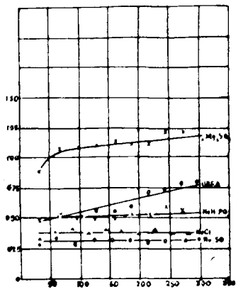


Fig. 3.

grease level is lowered and 2) the rate of exhaustion is reduced.

These results agree well with reports from the field about plant trials where nonionics were used in an unbuilt system. It was found in these cases that a high initial concentration of detergent was required for proper scouring.

It is interesting to note that at the 165 F temperature, water alone (0.0% curve) removes somewhat more than half of the total grease present in the wool.

Scouring Efficiency as a Function of the type of Builder Used.— The data shown graphically in Figure 3 indicate clearly the remarkable effectiveness of sodium chloride (NaCl) and sodium sulfate or Glauber's salt (Na_2SO_4). A comparison of these curves to the 0.10% concentration curve in Figure 2 illustrates the full magnitude of the effect. The addition of either sodium chloride or sodium sulfate is more effective than doubling the detergent concentration.

Urea appears to have little effect on the efficiency of the system, while magnesium sulfate (Mg_2SO_4) is decidedly detrimental. Monosodium orthophosphate (NaH_2PO_4) on the other hand is intermediate in effectiveness between urea and sodium chloride. It was noted that the skeins scoured with the orthophosphate builder were exceptionally white, giving the appearance of having been bleached.

Although time limitations did not permit it during this study it would have been interesting to investigate the effect of the combinations of monosodium orthophosphate and either sodium chloride or sodium sulfate, not only from the standpoint of improved colour of the scoured wool but also from the standpoint that the phosphate (pH 4.2) would maintain the pH of the system near the iso-electric point of wool. Since at this pH, wool is least reactive and therefore less susceptible to damage, a still better grade of scoured stock should result.

Scouring Efficiency as a Function of Sodium Sulfate or Sodium Chloride Concentrations. In order to determine the optimum concentration of sodium sulfate, a number of runs were made at various levels of salt concentration while maintaining the amount of detergent constant throughout. The percentage figures labelling the curves in Figures 4 and 5 indicate the builder concentration of the scouring bowl liquor.

The data show that at the 0.10% detergent level and at 165°F the optimum concentration of salt is in the neighbourhood of 0.10% for sodium chloride and 0.20% for sodium sulfate. As the amount is substantially increased beyond 1.0% the scouring efficiency is considerably reduced.

Hepworth (3) states that 15 to 18 times as much salt as nonionic below a total of 1% is recommended. This appears to be borne out by the results of the present work (see Figure 5) inasmuch as concentrations of sodium chloride at the 1% level and above decrease the efficiency of the system. According to Zimmerman (9) the optimum salt concentration is dependent on the particular nonionic used. This is reasonable since it is believed that the effect of the salt is to encourage micelle formation and thus force more of the detergent to the oil-water interface. The optimum salt concentration is thus a function of the solubility (cloud point) of the detergent. By the same token, however, the particular salt used, the temperature of the scouring liquor, and the detergent concentration must also play a part.

At or near the optimum level there appears to be no substantial difference between the effectiveness of the

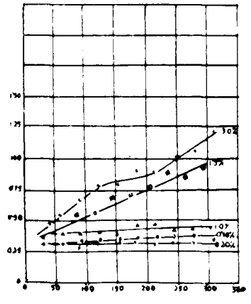


Fig. 4.

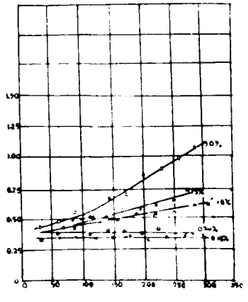


Fig. 5.

sodium chloride and sodium sulfate. On this basis and from the standpoint that in practical application sodium sulfate absorbed by the wool would be more helpful in dyeing than sodium chloride, sodium sulfate was chosen for all further testing.

Scouring Efficiency in a Built System as a Function of Nonionic Detergent Concentration.— In order to study the effect of the sodium sulfate builder on scouring efficiency at various levels of detergent concentration, the runs plotted in Figure 6 were made. The percentage figures labelling the curves indicate the concentration of detergent in the scouring bowl liquor.

A comparison with Figure 2 indicates that 1) the effect of changes in detergent concentration are minimized in the presence of the builder and 2) the builder tends to promote more uniform scouring, particularly at the lower detergent concentrations. The primary effects of the builder, namely, lowering the residual grease level and reducing the rate of exhaustion are of course, also in evidence.

Scouring Efficiency in a Built System as a Function of Temperature.— The runs plotted in Figure 7 were made in order to evaluate the effect of temperature on the scouring efficiency of a system containing 0.10% detergent and 0.20% sodium sulfate.

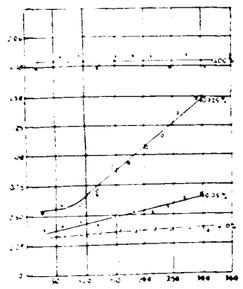


Fig. 6.

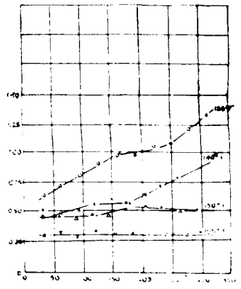


Fig. 7.

It is evident that the higher the temperature, the more efficient the system. As in the case of the other three variables detergent concentration, type of builder, and builder concentration the effect of temperature is to modify the residual grease level as well as the rate of exhaustion of the system.

Miscellaneous Data.— Curve A in Figure 8 represents the results of a soap and soda ash scour (0.15% low titer soap, 1.25% soda ash) at 140 F and is included for purposes of comparison to the other scouring methods. A comparison of Curve A to the 140 F curve in Figure 7 points up the much greater efficiency of the neutral scouring method. It seems reasonable to assume that this superior efficiency alone could make the neutral scouring system more than competitive with the regular soap and soda scour. Moreover, there seem to be a number of other advantages to be gained from this method. On comparing the skeins scoured by the soap-soda method to some scoured at 140 F with 0.10% nonionic and 0.20% sodium sulfate, the ones scoured by the latter method were found to be much whiter, softer feeling, and quicker drying. These advantages have also been reported by other workers in the field. (6,9)

Curve B dramatically illustrates the effect of sodium sulfate as a builder. In this case, a run was started using only 0.10% nonionic; partway through the run, 0.10% sodium sulfate was added. The resultant drop in residual grease is clearly illustrated.

Summary of Effect of Temperature and Detergent and Builder Concentration on Residual Grease Content.— Figure 9 illustrates the effect of these variables on residual grease content rather than scouring efficiency as a whole. Scouring efficiency is determined not only by residual grease content but also by the rate at which it increases with increasing amount of wool scoured. The points used in plotting these curves were taken from Figures 2, 4, 6 and 7 at the 250 g level (on the X axis). In view of the data, the following conclusion seem warranted.

(1) The relationship between temperature and residual grease content is approximately linear.

(2) The effect of increasing detergent concentration is very marked in the range of 0.0% to 0.20%, especially in the built sodium sulfate system.

(3) The sodium sulfate concentration is at an optimum in the range of 0.20% to 0.50% at a detergent concentration of 0.10%. Using too much sodium sulfate (above approximately 2.0%) can result in residual grease figures that are higher than those obtained with no builder at all.

SUMMARY OF LABORATORY RESULTS

(1) The nonionic-sodium sulfate (or sodium chloride) system represents an excellent method of scouring raw wool. It appears to be more efficient than the soap and soda method and produces whiter, softer and faster drying wool.

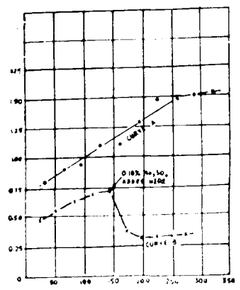


Fig. 8.

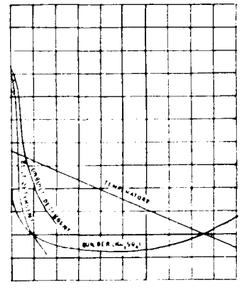


Fig. 9.

(2) The neutral scouring method affords four means of controlling scouring quality, namely, detergent concentration, type of builder, builder concentration and temperature. This makes this system particularly adaptable ove a wide range of operating conditions, since so many means of *effectively* controlling scouring efficiency are available. It should be emphasized that temperature is much more of a controlling factor in neutral scouring than in the alkali-containing systems since the presence of alkali usually limits operating temperatures to below 130—140 F due to the severe damage done to wool at higher temperatures. The limits imposed on temperature in the neutral system are dictated mainly by the limitations of equipment or economic considerations. It is not recommended, however that the system be operated above 180 F since at these temperatures some types of wool might be damaged.

(3) On the basis of the soft handle of the wool scoured by the neutral method, even when the grease content was very low, it appears that overscouring is not a danger with this system.

(4) Sodium chloride and sodium sulfate appear to be about equally effective as builders. When dyeing subsequent to scouring includes the use of Glauber's salt, however, it may be more advantageous to use sodium sulfate in the scouring operation.

FIELD TESTS

In order to substantiate the promising laboratory results and to translate the data into terms more useful from a practical standpoint, extensive field tests were carried out. These tests were performed in a number of plants under widely varying conditions (number and size of bowls etc.) and with a large variety of wools ranging from a carpet wools to domestic and Australian combing stock. Altogether, approximately fifty million pounds of wool were scoured.

The rates of detergent and builder addition necessary for continuous scouring are dependent on the types and origin of the wools being scoured as well as the feed rate. Some wools are easily scoured and others of approximately the same shrinkage characteristics are much more difficult to clean. It was impractical to try to determine these variables in the laboratory; therefore, they were worked out in actual, full scale plant production.

Other factors which had to be taken into consideration were the use of suint bowls and/or continuous grease recovery systems as well as equipment, condition of equipment, control availability of steam, water etc.

The principles of neutral scouring as determined in the laboratory were successfully applied in full scale plant production in four different scouring plants.

PLANT NO. 1

This plant was connected with a carpet mill and scoured all types of carpet wools. The equipment consisted of both four and five bowl trains of 48″ width. There was on suint bowl or grease recovery system.

Parallel tests were run in order to compare the nonionic detergent Glauber's salt method to their regular soap and soda ash scour. The neutral scour was run in the four-bowl train while soap and soda ash were used in the five-bowl train.

Shortly after operation was begun, it was found that the neutral scoured wool was considerably whiter, loftier and better feeling than that scoured by the soap and alkali method. As the neutral scouring progressed, it was noticed that the stock was much open, lofty, resilient and drier than more normal. As a result, it was found that the dryer could be operated at a temperature 20 below that normally used to obtain the moisture content necessary for the proper carding. The grease content of the neutral scoured wool averaged 0.4%, with a maximum deviation of ±0.2%, and the kind handle and resilience of the stock were very noticeable.

This particular plant operated on the basis of approximately 60% grease removal in Bowl #1 and 40% in Bowl #2 primarily to save on chemicals since sludge

dropping and bowl changes were most frequent in Bowl #1. The suds level ran appreciably higher than is normally expected due to the use of high velocity circulating pumps.

The procedure shown in Table 1 was worked out for this particular mill and gave good results.

PLANT NO. 2

This was a commission house handling all types of wool and operated with five bowl trains. Scouring had to be done in the first two bowls, rinsing in the third and fourth bowls, and bleaching in the fifth. Here again, there was no grease recovery system or suint bowl. The bulk of the grease (80%) had to be removed in the first bowl. See table II.

The amounts of peroxide and sulfuric acid needed in bleaching were substantially reduced.

The colour and handle of the stock were noticeably better and customer reaction was very favourable.

PLANT NO. 3

This plant operated a five bowl train equipped with a centrifugal grease recovery system. The ratio of water to wool in the first two bowls was very low in order to obtain maximum grease recovery. Both woollen and worsted combing wools were scoured in this equipment.

As the scouring progressed, it was found possible to cut the additions by 30% on the second day and by 50% from the third day on through the week. Operation was carried on for a full week without complete dropping of the bowls. See table III

Residual grease contents averaged 0.4% throughout a full week's run (200,000 pounds grease wool 62s—64s)

The improvement in colour and loftiness of the stock was immediately noticeable as compared to soap and soda ash scouring. It was possible to reduce the temperature in the dryer very substantially in fact, the heat was cut off entirely in the second section of the dryer.

There was a 1% decrease in noilage in combing which is very significant.

Grease recovery was increased by 20%; however it was of a darker colour.

TABLE I

Procedure at Plant No. 1

4 bowl – 48" train – 2400 lbs. grease wool per hour feed rate.

Bowl	*Initial Charge*	*Additions Each 30 Minutes*
Bowl # 1 2600 gals. 145 degree F	20 lbs. Nonionic detergent 40 lbs. Glauber's salt**	2 lbs. Nonionic detergent* 2 lbs. Glauber's salt**
Bowl # 2 1625 gals. 145 degrees F	8 lbs. Nonionic detergent 16 lbs. Glauber's salt	4 lbs. Nonionic detergent 4 lbs. Glauber's salt
Bowl # 3 1300 gals. 135 degree F	2 lbs. Nonionic detergent 4 lbs. Glauber's salt	only as needed as indicated by a light suds
Bowl # 4 120 degree F	Rinse	

Costs were approximately the same as for the regular soap and Soda scour (16 cents per 100 pounds grease wool)

* Kyro EO (Registered trade mark)

** Anhydrous

TABLE II

Procedure at Plant No. 2

5 bowl – 48" train – Average 1800 lbs. grease wool per hour feed rate

Bowl	*Initial Charge*	*Additions each 30 Minutes*
Bowl # 1 3000 gals. 140 degrees F	25 lbs. Nonionic detergent* 50 lbs. Glauber's salt Drop bowl to screen about every 6 to 8 hours and make a double addition.	2½–3 lbs. Nonionic detergent 2½–3 Glauber's salt
Bowl # 2 1500 gals. 140 degrees F	6 lbs. Nonionic detergent 12 lbs. Glauber's salt Drop bowl to screen about every 8 to 10 hours and make a double addition.	1½–1 lb. Nonionic detergent 1½–1 lb. Glauber's salt
Bowl # 3 1500 gals. 130 degrees F	Rinse.	
Bowl # 4 1500 gals. 120 degrees F	Rinse.	
Bowl # 5 1500 gals. 110 degrees F	Bleach.	

This formula was set up to provide for maximum utilization of Bowl 1 for scouring.

Extractions for residual grease content indicated very uniform scouring as they were consistently in the range of 0.3 – 0.6%.

Costs compared favourably with those for soap (tall oil) and soda scouring (17 cents per 100 lbs. grease wool).

TABLE III

Procedure at Plant No. 3

5 bowl - 48" train - 1500 lbs. grease wool per hour feed rate.

Bowl	*Initial Charge*	*Additions per hour*
Bowl = 1***		
975 + 900 =		
1875 gals.	15 lbs. Nonionic detergent*	4-5 lbs. Nonionic Detergent
145° F	30 lbs. Glauber's salt**	4-5 lbs. Glauber's salt
		Additions are made until the grease recovery system starts and are then stopped.
Bowl = 2		
975 gals.	8 lbs. Nonionic detergent	4-5 lbs. Nonionic detergent
145° F	16 lbs. Glauber's salt	4-5 lbs. Glauber's salt
Bowl = 3		
1796 gallons	8 lbs. Nonionic detergent	1-2 lbs. Nonionic detergent
145 F	16 lbs. Glauber's salt	4-5 lbs. Glauber's salt
Bowl = 4		
1397 gals.	2 lbs. Nonionic detergent	1-2 lbs. Nonionic detergent
130 F	No Glauber's salt	As needed to maintain a light suds
Bowl = 5		
1397 gals.	Rinse	
120° F		

(since bowls 1 and 2 are so short, they were operated as if they were a single bowl)

***Grease recovery storage tanks

TABLE IV

Procedure for Plant No. 4

Bowl.	*Initial Charge.*	*Additions per hour.*
Bowl = 1		
2700 gals.	suint (water only)	
90° F		
Bowl = 2		
2200 gals.	18 lbs. Nonionic detergent	6 lbs. Nonionic detergent
145 F	36 lbs. Glauber's salt	12 ibs. Glauber's salt.
		Additions are made until the grease recovery system starts and are then stopped
Bowl = 3		
1700 gals.	8 lbs. Nonionic detergent	4-6 lbs. Nonionic detergent
145° F	16 lbs. Glauber's salt	8-12 lbs. Glauber's salt.
Bowl = 4		
1500 gals.	1 lb. Nonionic detergent	As needed to maintain a light suds.
135 F	No Glauber's Salt	
Bowl = 5		
120° F	Rinse	

Costs of materials were less than with soap and soda ash (13 cents versus 16 cents per 100 pounds of grease wool).

PLANT NO. 4

This plant is engaged in commission scouring and combing and handles all types of combing wools. They operate both four and five bowl trains equipped with centrifugal grease recovery systems and also do some bleaching.

This plant was already neutral scouring some of their wools but at higher temperatures (160—195°F) and without Glauber's salt. The rest of the wool was being scoured with soap and soda ash. See Table IV.

The improvement in colour, lower drying temperatures, etc. were also obtained here as compared to the soap and soda ash scouring. A higher grease recovery and better coloured grease were also obtained as compared to neutral scouring at 165° F without Glauber's salt.

Wools scoured with the Nonionic Detergent and Glauber's salt ran noticeably better in carding and combing than the same wools scoured neutral at higher temperatures without Glauber's salt.

CONCLUSIONS

Since equipment and wools vary so much from plant to plant, it is not possible to give a specific procedure to fit all conditions. For best results, each plant should have a "tailor-made" procedure for its specific conditions and equipment although there are certain minimum starting concentrations of detergent and builder which will apply in all cases. The temperatures used will depend on the individual plant and its ability to maintain a uniform temperature.

The laboratory work showed that starting concentrations of 0.1% Non-ionic Detergent and 0.2% anhydrous Glauber's salt solutions were necessary for adequate scouring in the first scouring bowl (about 8 pounds of detergent and 16 pounds of Glauber's salt per 1,000 gallons of solution). This starting concentration when used in the plant tests gave good results. Scouring Bowl 2 can usually be operated at one half the concentration of scouring Bowl 1 (i.e., 4 pounds of detergent and 8 pounds of Glauber's salt per 1,000 gallons).

Additions to these bowls had to be based on the feed rate as well as the types of wool. When scouring was done *without* a suint bowl, detergent and Glauber's salt were added in equal parts. When scouring was done with a suint bowl, it was found advisable to make additions in the ratio of 1 part detergent to 2 parts of Glauber's salt.

The usage of detergent and salt varies with the types of wool scoured as well as the grease content. The usage is also affected by the scouring method employed. Obviously, systems utilizing continuous grease recovery and returning the recovered detergent, etc. to the bowls are more economical to operate than those without grease recovery systems. On the average about 0.5% Nonionic Detergent and from 0.6% to 1.0% of Glaubar's salt on the weight of the grease wool scoured give satisfactory results.

The higher the temperature, the more efficient the scouring; consequently less scouring materials are needed.

When a grease recovery system is used, it is possible to run a full week by dropping the scouring bowls to the screen only at regular intervals and making up with fresh water.

Residual grease contents tended to run slightly lower than considered ideal for the conventional soap and soda ash type of scour. However, the fibre showed none of the customary characteristics associated with over-scouring. The system has been operated on a basis of 0.3% or less residual grease without any of the usual symptoms of low grease content, such as dry, harsh or wiry handle.

This system is particularly adaptable to the scouring of pulled wools in that there is little danger of lime soap formation. This minimizes the possibility of gumming up the card clothing and obtaining streaky or uneven piece dyeing. Undesirable odors which sometimes develop on a storage in piece goods containing residual lime soaps are largely eliminated.

As in any new process, there may be certain disadvantages such as the higher temperatures required. Some plants may not have boiler capacity sufficient to provide the heat required. Recovered grease is generally darker in colour

Observations indicate that paint contaminated wools may be harder to handle in the neutral system, than by

the soap and soda ash method, primarily because of the higher temperatures used which tend to soften and spread the paint more.

ADVANTAGES OF NEUTRAL SCOURING

The results of extensive field tests show that the neutral raw wool scouring system has the following advantages over conventional soap and soda ash scouring.

(1) Easily handles all kinds of wool from the coarsest to the finest.

(2) Exceptionally good on wools stored for a long time.

(3) Wool has noticeably whiter and better colour.

(4) Increased production (5%—15%).

(5) Fibre has a better feel.

(6) Blueing more uniform.

(7) Less peroxide required to bleach.

(8) Less acid required in the bleach.

(9) Better pH control of fibre (pH ranges from 6—8)

(10) Produces loftier wool.

(11) Much faster drying.

(12) Greater staple length in worsted wools.

(13) Lower noilage in combing (as much as 1.0% less)

(14) Higher top yields.

(15) Higher grease recovery (upto 20% more).

(16) Practically impossible to overscour. (This is from a fibre handle standpoint, not grease content.)

(17) Costs compare favourably with conventional soap and soda ash scouring (12 cents to 20 cents). In many cases, costs are less.

(18) Handles pulled wools very well without special precautions.

(19) Much less materials to be handled.

Industry reaction indicates that the advantages to be gained in neutral scouring far outweigh the disadvantages and it appears that "neutral" scouring is here to stay and represents a milestone in the history of wool processing.

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REVISED ESTIMATES OF STEEL PLANTS

The original estimates in regard to the Rourkela, Bhilai and Durgapur steel projects have been recently revised. The original estimates were: Rourkela, Rs. 128 crores; Bhilai, Rs. 115 crores and Durgapur Rs. 115 crores. These estimates did not include the cost of the three townships, two ore mines, fees of the consultants and the cost of Indian and foreign experts.

There has been an increase, in the estimates of the Durgapur and Rourkela steel plants mainly on account of a rise in cost of material and labour in the countries from which plants are to be imported. The Durgapur Plant is now expected to cost Rs. 138 crores and the Rourkela Plant about Rs. 170 crores.

The estimates for the Bhilai Plant are being revised; they are also expected to show an increase.

* * *

EXPERT COMMITTEE ON ALUMINIUM

The expert committee for the development of aluminium industry, appointed by the Government has submitted its report. The report broadly surveys the potentialities of production of aluminium in the country. It is indicated that the economic unit of production would be one producing about 10,000—20,000 tons of aluminium per year. With power cost at a level of about Rs. 120-30 per KW year, it should be possible to manufacture aluminium in the country economically. The report indicates that the site at Mettur in the Salem District of Madras State is suitable for installing a 10,000 tons unit; another suitable site suggested in Rihand in Uttar Pradesh.

SPRAY DRYING

How it can boost production for you?

By A Technical Correspondent

WITH the increased trend toward the use of automatic controls throughout many industries today, the natural tendency is to examine your own processing steps and ask, "Where can I benefit from automatic control?"

One of the more important steps in the ceramic industry is that of drying. It is now possible to incorporate a drying method in your production line which is completely automatic and, in addition, produces a superior product and cuts down on production steps. Spray drying is the method which provides these advantages.

WHAT SPRAY DRYING IS

Spray drying is a process for converting solutions, slips or slurries almost instantly into a dry, free-flowing product in one drying step. It involves first atomizing the liquid feed into droplets or "spray" within an enclosed chamber into which heated air is introduced. In this rather turbulent heated air environment, the water is evaporated instantly from the droplet with a corresponding rapid drop in the drying gas temperature. The dried particles are then separated from the air stream by conventional recovery methods.

This method does not rely on a vacuum within the drying chamber. A rapid rate of drying is possible because the very finely atomized droplets are so well dispersed within the heated air stream. The product of the spray drying process is characterised by a spherical, free-flowing particle which lends itself quite readily to moulding and pressing operations.

Briefly, a list of spray drying advantages would be as follows: (1) continuous operation; (2) production of free-flowing dust-free powder of uniform particle size and bulk density especially suited for dry pressing; (3) low labour cost; (4) favourable heat economies since the high initial temperature of the drying air may be used without the products being exposed to excessive heat. This, of course, is important where volatile additives are contained in the slip or slurry. (5) capacity is easily varied (6) no dewatering step is required before drying (7) dried product is easily handled by air conveyors (8) minimum amount of moving or wearing parts (9) high quality of product and brief retention time of the product in the dryer (10) low maintenance costs (11) extreme flexibility of operation possible through combination with air calcination or secondary drying systems. (12) freedom from contamination (13) precise control of final moisture.

POSSIBLE DISADVANTAGES

One disadvantage may be in the production of small quantities of dried products, but some of the manufacturers of spray drying equipment have designed spray dryers specifically for electronic ceramics which meet the small production requirements of this application.

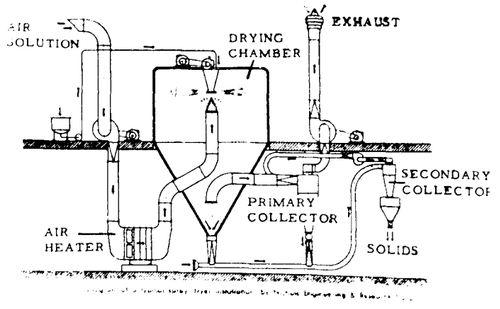
In the manufacture of wall tile body by the new method, including high speed spray bowl drying, the slip is pumped from the storage tanks directly into the spray drying unit and is instantly transformed into a pelletized body and delivered to bins ahead of the tile presses. This is truly automation free from hand labour.

A well known tile company states: "This pioneering in new techniques, using new and better equipment, has produced not only greater quantity, but better quality of product as well, while effecting an economy of labour and an ultimate over-all cost reduction for the finished product."

OUTLINE OF PRODUCTION STEPS

The following is an outline of the production steps required in ferrite production first by the conventional methods and then by spray dryer method.

SPRAY DRYER...for solutions



The conventional method: (1) Ball milling of iron oxide. (2) Filtering of slurry on filter presses. (3) Mixing of filter cake with binders. (4) Partial drying of mixture in tray dryers (5) Breaking up of semidry material. (6) Treatment in granulizer. (7) Finer drying of granular product in tray dryer (8) Sifting of powder (9) Recycling of fines to the ball mill.

By the use of spray drying, the nine steps are cut to four, consisting of: (1) Ball milling of iron oxide. (2) Mixing of binder in liquid form (3) Drying of slurry in spray dryer with automatic classification (4) Recycling of fines to ball mill.

COMPLETE AUTOMATIC CONTROL

Once the operating conditions are determined, usually in the research laboratories of the manufacturer, the spray drying operation requires that only the inlet and outlet air temperatures be controlled by controlling the air heater, be it indirect or direct fired, gas or oil, steam or electrically heated. Since there is no load change in this part of the system, a controller, with no reset action is sufficient.

Whether or not a proportional controller is needed, the extent of the proportioning band required will be determined by the type of air heater used. A direct-fired heater would probably require a relatively large proportioning band, whereas an indirect heater would require little or no proportioning band.

The temperature difference between inlet and outlet air is a function of the cooling effect of the evaporating solvent, in the drying chamber, and is directly related to it, other conditions being constant. This outlet air temperature is therefore controlled by adjusting the feed rate to the dryer. For this part of the system, a proportioning controller with reset action is necessary because of the possibility of load changes in this part of the spray drying system.

It can be readily seen that the entire operation can be controlled automatically without difficulty and requires only one operator for the entire set-up.

A change over to spray drying and the merits of its ease of operation and control along would be justified however, because this drying method produces other advantages as mentioned previously, such as uniform particle size. free-flowing high bulk density etc. The advantages of such product properties are apparent to all ceramic producers.

ABRASIVE SLIP NO PROBLEM

You may then say to yourself, "What about the abrasive characteristics of ceramic slips? How soon will an atomizer wear out and cause product contamination?" Because these are such vital questions to ceramic producers much time, effort and money has been spent in answering these questions. An atomizer wheel sold exclusively by one of the manufacturers of spray drying equipment is in use now in a dryer producing highly abrasive electronic ceramics. This wheel has withstood over 500 hours of production without signs of abrasion, where a wheel with $\frac{3}{4}$" thick stainless steel vanes would be completely cut through in 40 hours.

In general, if the slip can be pumped readily, it can be spray dried. If the material normally available to the dryer is too thick for pumping, it can frequently be handled by agitation if it is thixotropic, by use of dispersing or deflocculating agents, or by diluting the slip to a pumpable consistency.

A single spray drying unit can be designed for almost any production rate than can be justified on the basis of good engineering economics. The volume of slip that can be handled per hour can be varied in almost any direction depending on the size of the unit. Capacities vary from 250 lbs. per hour of solids on electronic ceramics to 20 tons of slip per hour.

CONTAMINATION CONTROL

The spray drying process lends itself quite readily to high quality and high purity production with freedom from any contamination. More recent units in the ceramic industry have been furnished with stainless steel drying chambers, stainless steel primary collectors and stainless steel scrubbers so that all the material that is dried and recovered comes in contact only with stainless steel throughout the process.

Although not normally required dryers can be fitted with inlet filters to remove even airborne dust from the final product. If natural gas is available for the heating fuel, furnaces can be designed and operated so that there is absolutely no contamination or carry over in the final product.

In certain extreme cases where liquid fuels are available, it might be advisable to use an indirect heater for the drying air.

Naturally, spray drying costs on a pound of water evaporated basis will be higher can cost for mechanical de-watering or multiple effect evaporation. It must be borne in mind, however, that in spray drying the liquid feed is taken directly to the finished free-flowing dry product and to evaluate the savings in spray drying, the over-all continuous process must be analyzed and compared with alternate processes using other types of drying, rather than comparing spray drying directly with tunnel drying, or with filtering.

The thermal efficiency calculated for a particular drying step alone does not tell the complete story. Let us take a typical application which might be encountered in the industry, involving a wet milling operation on a batch basis where the material would then be discharged and later pumped to a centrifuge removed from the contrifuge and then transferred to tray dryers or to a drum dryer, from the discharge of which it would be handled to a grinding or a classifying operation. after which it would be packaged or sent on to subsequent processing.

The alternate method would be to discharge from the wet mill into a hold tank of sufficient capacity to hold more than one batch from the wet mill. From this hold tank, the slip then could be fed continuously at a uniform rate to a spray dryer, from which it could be discharged in dry free-flowing form directly to the packaging equipment, thus eliminating all the steps in between required in the method mentioned previously. This spray drying installation could be set up with controls to operate automatically round the clock with a minimum of supervision and with absolutely no handling of material between the wet milling and the packaging.

SAVINGS WITH SPRAY DRYING

Undoubtedly, if the total production requirements on a 24-hour basis were in the neighbourhood of 100 lbs. per hour or greater, the spray drying operation would show substantial savings in fuel, operating capital and maintenance cost over the alternate process.

One of the manufacturers of spray drying equipment estimates that when spraying costs, as well as labour, amortization, taxes, power, etc., are taken into consideration, and compared to filtering and single conveyor drying, the cost of spray drying would be approximately 0.92 of the lattet system.

Drying in a system using plate and frame filters, it would be $2\frac{1}{2}$ to 3 to 1. Finally, for ceramic clays requiring longer, filtration because of their individual physical characteristics, the ratio could possibly be four or five to one.

The final moisture of a spray dried product can be controlled very precisely, according to the manufacturers. The control of dryer operating temperatures in the installation can be set up quite easily and inexpensively for automatic control of these variables. The control can be exercised to give either higher or lower final moistures then would be possible with the same material in other types of drying equipment. The manufacturers of spray drying equipment claim control of final moistures as low as 0.05%. Moisture control ranges down from 10% to the former figure.

WHERE CALCINATION IS REQUIRED

Where subsequent calcination of the dried material is required a simplified and very economical arrangement involving spray drying and pneumatic calcining is possible. Under such an arrangement, slurry is fed to the spray dryer at maximum feed rates with a correspondingly low outlet air temperature. The dried material is then discharged from the primary cyclone of the spray dryer in the normal manner through a rotary dustlock into a pneumatic conveying duct system which uses high temperature dry air which has been by passed from the spray dryer aerator.

The dried material is retained long enough in the conveying air stream to accomplish the calcination or secondary drying as required, and at the same time may be physically transported to considerable vertical or horizontal distances.

The calcined material is recovered from this secondary air stream by a much smaller cyclone collector which can be arranged to discharge directly into a packaging or storage hopper. The heated conveying air stream exhausting from this cyclone collector is recycled back into the air heater of the spray dryer so that the waste heat from the calcining operation is recovered.

INDEPENDENT TEMPERATURE CONTROL

In such an arrangement the inlet and outlet temperatures of the calcining system can be controlled independently of the spray dryer inlet and outlet temperatures and an extremely favourable heat balance in the two processes can be obtained.

The space, fuel and power requirements and the capital cost of the combined processes is not much greater than the requirements of a spray drying process alone. Such an arrangement is sometimes indicated where very precise control and a very low final moisture are required and the material has a somewhat higher equilibrium moisture. Such an arrangement can also be operated either with or without the secondary drying or calcining system so a great deal of operating flexibility is possible.

MAINTENANCE COST

Since the typical spray drying arrangement is quite simple and compact and the one process usually supplants several other processes, it means that maintenance costs will be considerably less with a spray dryer installation than for alternate types of equipment. On the larger installations, it has been estimated by one manufacturer that this could actually be figured as low as 3 to 5 per ton of product.

CONVENTIONAL METHOD Vs. SPRAY DRYING

Conventional Method	*Spray Drying*
1. Ball milling of iron Oxide	1. Ball milling of iron oxide
2. Filtering of slurry	2. Mixing of binder
3. Mixing of filter cake	3. Drying of spray dryer
4. Partial drying in trays	4. Recycling to ball mill
5. Breaking semidry material	
6. Treatment in granulizer	
7. Finer drying in tray	
8. Sifting of powder	
9. Recycling to ball mill	

(Courtesy : Ceramic Industry)

RECOMMENDATIONS FOR THE RADIOGRAPHIC EXAMINATION OF FUSION WELDED JOINTS

The Indian Standards Institution has recently circulated for eliciting comments draft Indian Standard Recommendations for the Radiographic Examination of Fusion Welded Joints.

In recent years considerable development has taken place in the field of welding. Non-destructive tests for materials and components are increasingly used in all fields of engineering technology. In the field of testing of welds Radiographic examination is becoming popular. This standard sets out recommendations for the radiographic examination of fusion welded butt joints in steel of thicknesses upto 50 mm. A technique for gamma-radiography is given for examinations in which, because of dimensional, portability or other limitations, X-ray equipment would present problems outweighing the inherent superiority of X-ray as against gamma ray examination for thicknesses of steel up to 50 mm.

In the preparation of this draft standard the Sectional Committee kept in view the practices followed in the country in this field. Furthermore, due consideration has also been given to the need for co-ordination with standards being followed in other countries.

In view of the decision of the Government of India to introduce metric system of weights and measures in the country, equivalent values in metric units have also been included in the draft standard in addition to those in ft.-lb. system.

Comments are invited on this draft standard by 30 July 1957 and all interested parties can obtain its copies from the Indian Standards Institution, 19, University Road, Civil Lines, Delhi-8, or its Branch Offices at 40 40A Cawasji Patel Street, Fort, Bombay and P-11, Mission Row Extension, Calcutta.

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BIGGER TANK FOR SMALL CAR

A larger fuel tank is now being fitted to the Morris Minor. The Nuffield Organization, makers of the car, say that 300 miles without refuelling should now be attained. The 5-gallon tank previously fitted is being replaced by a tank of 6½ gallons capacity.

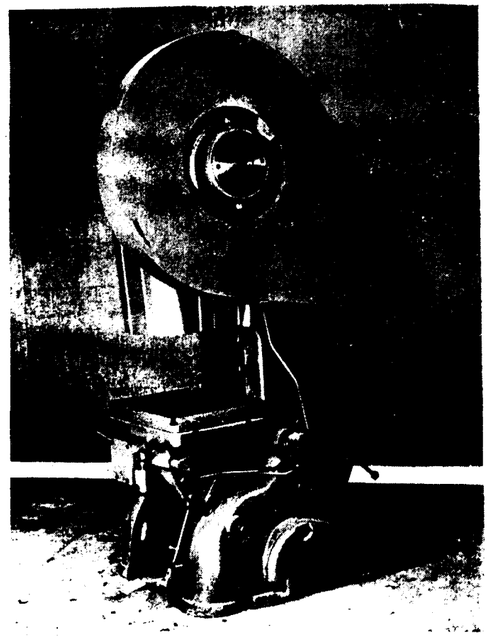
"Despite the extremely good petrol consumption of the Minor", said a Nuffield spokesman, "it has been felt that giving the car an even greater range would please many people, particularly in those oversea countries where filling-stations are few and far between".

Outstanding Progress in the Manufacture of Czechoslovak Machine Tools

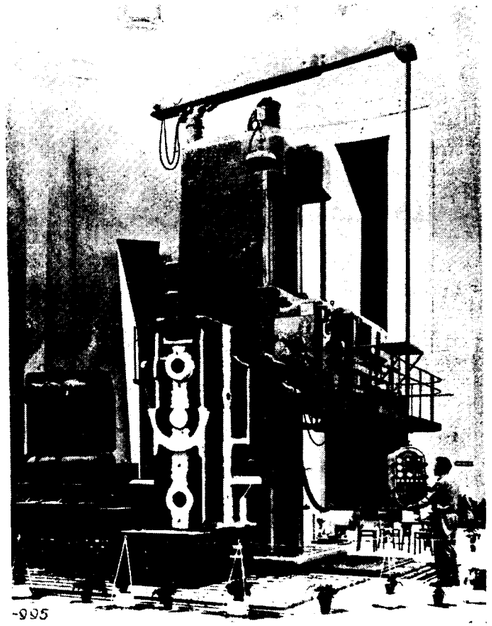
By Director of Publicity, Strojexport, Praha.

THE Czechoslovak Machine Industry, right from its beginning held in Europe a position of prominence and the products of some factories, those of the SKODA Works for instance, had established themselves on the world market as early as in the last century. It is only natural that in a country having a well developed and voluminous machine industry, a machine tool industry of its own should have been born.

In the initial stage, larger plants used to manufacture special machine tools for their own use. Yet the actual growth of the Czechoslovak Machine Tool Industry coincided with the years following the end of World War I. As a result of the recognition won by the products of the pioneering works, new factories sprung into life and new types of machine tools were developed.



Another Press Model LEN 12, 5



Horizontal boring and milling machine Model WO-250

Czechoslovak Machine Tools, in particular those bearing trade marks like SKODA, Zbrojovka, Volman, Kamenicek, Mas and others gradually won their way into the world market because of their excellent quality.

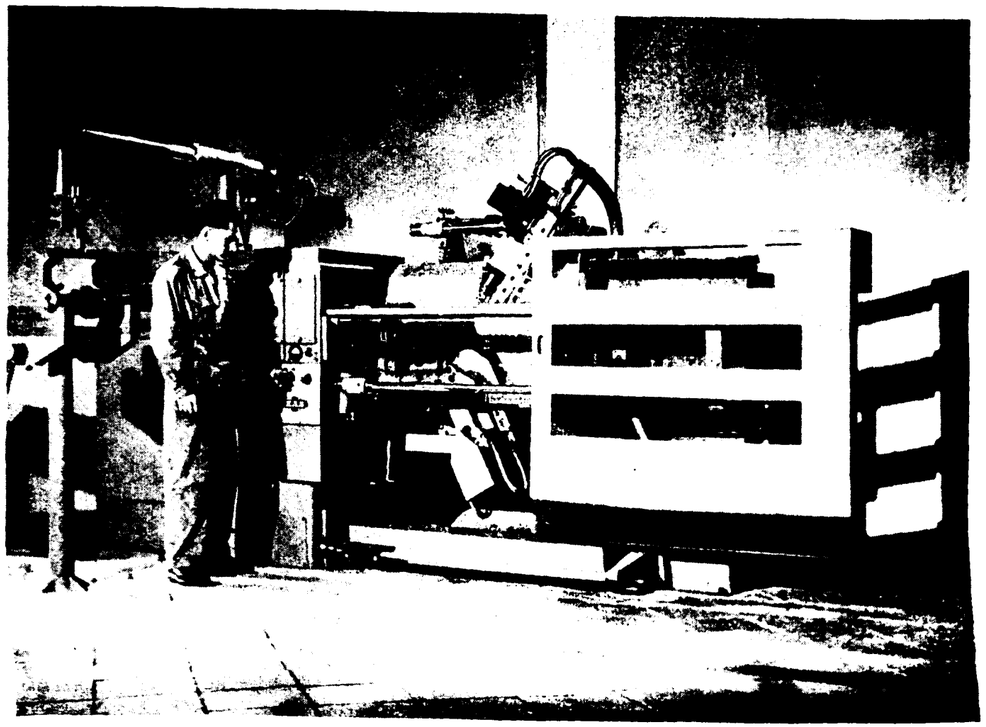
To-day, the manufacture of Machine Tools benefits from a tradition of long standing, carried on by a numerous staff of experienced designers while the development of new machine types is based on the research work of a well equipped scientific research institution. Progress in this field is in no small measure due to the support received by the planned type of the economic system. It has been possible to centralize, and thus to specialize, a widely diffused production, to introduce central management and to ensure exchange of experience between individual works. In consequence of the selection of machine tools types enforced by the central management, the number

of machine tool types in construction has been reduced, doing away with the practice of one and the same type being manufactured simultaneously in several works. Serial production is profitted by perfect preparatory work and improved production mediums. The combination of those factors resulted in a more economical, as well as in more perfect products. The productive forces thus released found employment in the manufacture of machine tool types of more recent development.

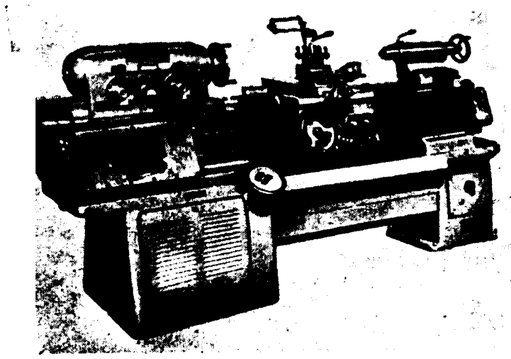
Czechoslovak Machine Tools of to-day, uniformly bearing the new triangle trade mark with the letters TOS, continue in a long established tradition and comply with world technical standards. Their design is both purposeful and economical.

Czechoslovakia manufactures nowadays simple as well as intricate types of universal machine tools in sufficiently stepped-up sizes and a large number of special machines, inter alia also single purpose units. Production covers the widest possible range, from light and medium-sized machines up to the very heaviest having a weight of over 100 tons. The production range being what it is, the user may choose among the machines from the point of view of the most suitable and the most agreeable to the purpose, both for machining by the chip-detaching or the chipless method, for single piece production as well as serial or mass production. He will also find simple and low priced machines to meet the requirement of tradesmen and repair shops.

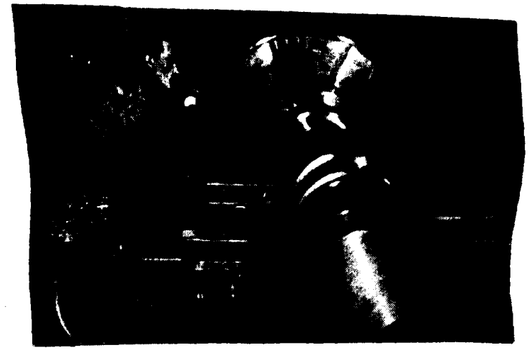
In the branch of lathes, there is a good number of types that are manufactured in Czechoslovakia, ranging from the smallest sizes of 160 mm. turning diameter up to heavy and heaviest lathes with 3150 mm. swing over bed and a working length of 25 m. Apart from all common conventional lathes, the more universal types of which can be equipped with a hydraulic copying attachment, there are also production lathes for serial work, Capstan lathes, a range of special purpose lathes turning



Semi-automatic lathe type SP-31 with automatic working cycle.

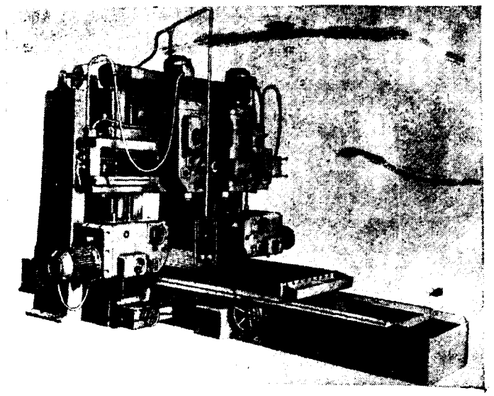


Type SV18R high speed universal Lathe Zbrojovka.



Skoda high speed lathe type SRX-1000 with electronic function control.

Skoda vertical milling machine type FV-1000 with automatic working cycle.

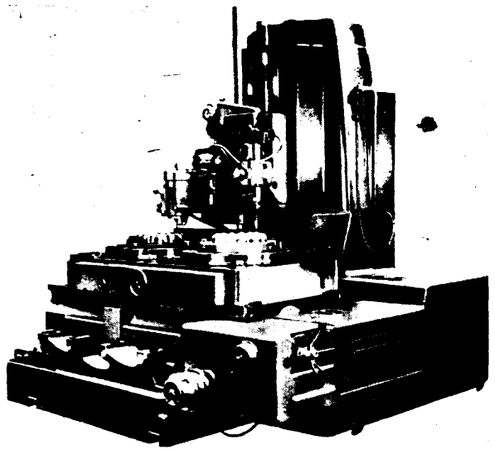


Plano milling machine model FP-16.

and boring mills of different sizes, accommodating work up to 5 m. in diameter, semi-automatics as well as single-spindle and multi-spindle automatics.

Best sellers in many countries on all the Continents are the type SN 20 and SV18R universal lathes. Of 380 mm. respectively 400 mm. diameter, these lathes are of a size that proves most popular as it will permit making full use of the machines. Lathe SN 20 is a precision machine, suitable for all conventional turning operations in both single piece and serial production. The SV18R Zbrojovka lathe is engineered for work requiring graduated precision, the wide speed range it incorporates enabling economical turning of all kind of materials. The machine can be fitted with a hydraulic copying attachment used to advantage when reproducing work of intricate design; the copying attachment thus enhances the productivity of the lathe.

Of late, our production programme of universal lathes has been enlarged by the incorporation of the newly designed type SU lathes. Having a swing over bed of 350 and 900 mm. these machines are of the medium class. Several new principles have been introduced into their design, resulting in a more graduated precision and a both simplified and quicker control. The remarkable capacity of the driving motors combined with a wide range of feeds and speeds allow full use to be made of carbide-tipped cutting tools. These machines are also built in simplified execution, for increased productivity in serial production.



Copying milling machine with electric tracer control MAS model FKO8c.

Profitting by the experience of the SKODA Works, new series of heavy and high speed lathes have been developed which are supplied with a swing over bed of 1000 and 1250 mm. and a working length of 12 m.

The new type of Vertical Boring and Turning Mills with a clamping of up to 4000 mm. and 5000 mm. in dia. and admitting loads of up to 40 tons are endowed with fluently controlled speeds and remote control of main function by means of push buttons.

As far as Milling Machines are concerned all common kinds and sizes are manufactured in Czechoslovakia and comprise the fixed-stand type, universal milling machines, plano-millers admitting workpieces of up to 3150 mm. and special milling machines for miscellaneous purposes such as copying millers, slotting millers, cam milling machine and miller for turbine shovels etc.

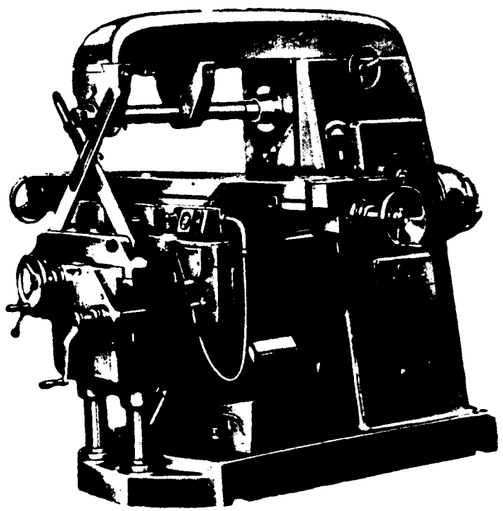
Much in demand all over the world are the Zbrojovka made type FA milling machines delivered in four different sizes, with table dimensions from 200 × 1000 mm. up to 425 × 200 mm. Of either the horizontally or vertically mounted spindle type, these millers can be fitted with both universal and swivelling table. Main features are high output of motor, superior rigidity centralized and highly perfected operational control and a particular wide range of accessories by virtue of which work may be performed that otherwise would call for the use of a special purpose machine. These millers can also be delivered with automatic working cycle, and adjustable table stocks, conveniently used during serial production.

Simple but at the same time fully perfected, machines from a technical point of view are embodied by the type F2a milling machines with table 300 × 1350 mm. in size. Although of lesser weight, these machines are of sufficient capacity to afford many-sided application as they will work all kind of materials and perform most intricate operations.

In the category of grinding machines produced in Czechoslovakia are comprised all common sizes of universal centre grinders for grinding up to 660 mm. dia. as well as internal grinding machines, surface grinders in different execution, universal tool and cutter grinders and grinding machines for special tools such as turning and planing tools, twist drills, button dies, saws, cylindrical grinders, grinders for cams, valves, piston rings and many other kinds.

The widest possible application is afforded by the 80A centre grinders. The working headstock and the grinding headstock are of the swivelling type, as a result of which also tapers can be ground or, if required, cylindrical and face areas may be ground simultaneously by the circumference of the grinding wheel.

During serial production the automatic working cycle may be applied, each of the individual functions



FA5U type Universal Milling machine Zbrojovka.

of the machine such as grinding wheel motion, sparking-out time, withdrawal of grinding headstock, wheel dressing, disengaging of the machine, shutting-off the coolant supply and other functions being incorporated in the automatic working cycle. All these functions will automatically repeat in the adjusted sequence, so that the operator has merely to clamp and unclamp the workpiece and engage the machine by the main lever.

A similar automatic working cycle is provided on the new type of surface grinding machines which include also a turn-table type grinder.

The group of drilling machines is represented by all current types of single-spindle vertical drilling machines in table, column and heavy-duty upright executions up to 50 mm. dia. drilling capacity, also radial drilling machines with a drilling capacity up to 100 mm. with arm extensions up to 4000 mm. This group comprises furthermore adjustable multi-spindle drilling machines, reboring machines, horizontal boring machines of spindle dia. from 63 to 200 mm. in bed or moveable column type execution, and special single purpose drilling units for use in serial and mass production in a variety of industrial branches.

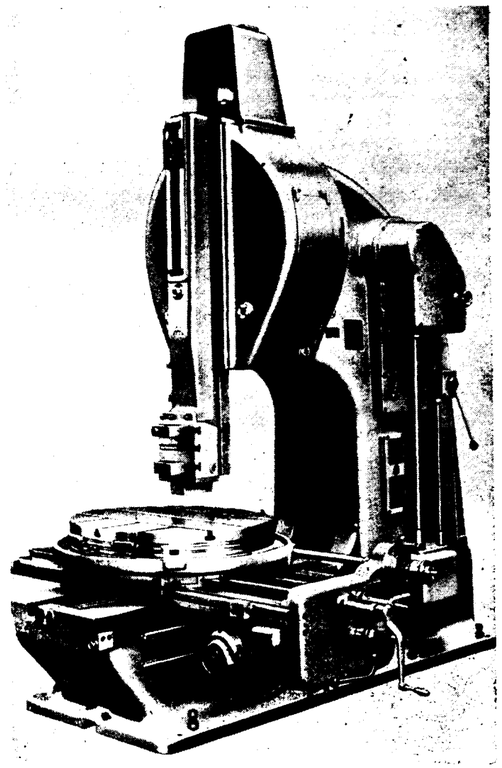
Special mention for the popularity they enjoy abroad deserve the VR Radial Drilling Machines. They enable economical drilling in single piece and serial production.

Universal Radial drilling machine VRM-50.

Owing to the great working range afforded and the simplicity of control, these machines may be operated by less skilled labour.

Besides horizontal boring machines in bed-type execution of 63, 80, 100 and 160 mm. also moveable column type horizontal boring machines from 125 mm. up to 200 mm. spindle diameter are manufactured in Czechoslovakia. High-output machines with remote control of the main motions and performances are suitable for milling and boring operations on heavy work clamped on the base plate located next to the machine.

Czechoslovakia manufactures yet many other kind of machines working on the chip detaching principle such as single arm and double housing planing machines for work of a width up to 3150 mm. and 10 to 20 m.



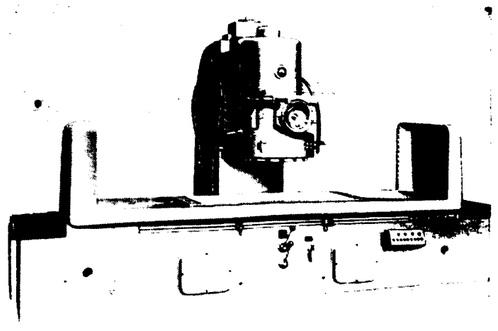
Type HOV-75 vertical slotting machine.

length, slotting machines, shaping machines, circular saws, hack saws etc. Also manufactured in Czechoslovakia are gear generating machines such as hobbing machines for spur gears and helical gears for dia. of gears up to 3000 mm. also gear shapers for the generating of internal and external spur gears as well as tooth grinding machines, all of which are of the most intricate design and built to satisfy most exacting demands for precision. There are yet many other types of special and single purpose machines produced in Czechoslovakia, for use in the diverse branches of the metal industry and which proved reliable production assistants in Europe and overseas countries.

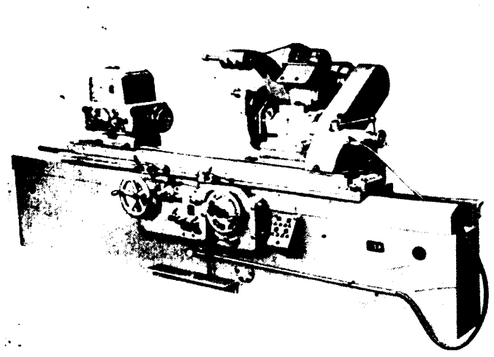
Not less complete is the range of machines operating on the chipless principle. All common types of mechanical hand presses, crank and friction presses are produced, a range that embraces the smallest machine up to the heaviest type of a working pressure of 1000 tons and over, as well as a large number of special presses for use in diverse branches of the metal industry. Into this category belong also forging hammers, forging presses etc.

The production programme includes furthermore metal sheet working machines such as plate, circular and profile shears, bending machines, rounding machines and straightening machines.

Also several types of hydraulic presses are manufactured in Czechoslovakia. A conspicuous position in export is occupied by presses for working bakelite, especially by the medium-sized presses 100 lbs. While preponderantly engineered for working bakelite and other artificial matter in heated moulds, they will



Surface grinding machine Model SPV-700.



Universal Grinding Machine 5U.

work with the same efficiency wood, metal sheets and ceramic stuff. Semi-automatic working control is enabled by time relays. Excellent renown throughout the world is enjoyed by the Czechoslovakis-made Die casting machines system Polak. These are essentially hydraulic presses, the operating principle consisting in the molten metal being injected into the double die by the movement of the piston. Castings can be obtained from aluminium, magnesium zinc or copper alloys. The finish of the castings being very smooth and as the casting technique will allow attainment of lowest tolerances, the necessity of giving after treatment to the finished product is obviated.

The above mentioned review covers only the main types of Machine Tools manufactured in Czechoslovakia. The actual production programme, however, covers some hundred machine types, not to mention those that are at present in the process of development.

Interested parties may obtain detailed information from STROJEXPORT, Foreign Trade Corporation for the Export of Machines and Machinery Equipment, Prague.

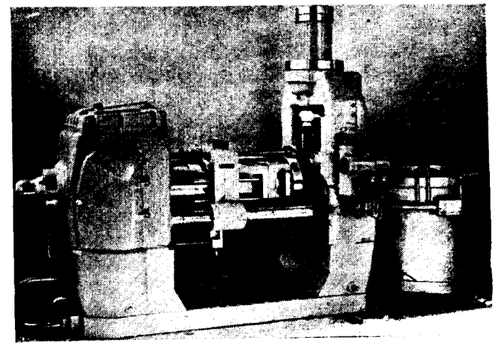
The production schedule of the Czechoslovak TOS machine tool works, which can look back upon a manufacturing experience of almost half a century, comprises nearly 500 different types of machines. In volume of production Czechoslovakia ranks to-day in fourth to fifth place among the world's largest producers, just after the USA, the German Federal Republic, the United Kingdom and Switzerland.

The following figures will give a more detailed picture of the total production: while in 1937 the

Czechoslovak production amounted to 5,000 machine tools, the number in 1948 has already risen to 11,000, continued upwards to 21,000 machine tools in 1955 and is expected to reach a production height of 34,000 high-quality machine tools by 1960, which in their design and workmanship are fully equal to all requirements of today's metal-working technique.

The export of Czechoslovak metal-working machines dates back to the years before the Second World War when machines of the SKODA, ZBROJOVKA, VOLMAN, KAMENICEK, PODHAJSKY types successfully made their way to the world's markets. Right after the World War II and during the first post-war years exports rose rapidly and by 1948 they were already 180% higher than the 1937 figures. Thus Czechoslovak machine tool exports in 1953 exceeded the country's pre-war level 9-fold, participating in value of exports with 8 to 9 percent in the world's aggregate exports of metal working machines in that year. Among the world's foremost exporters of this commodity Czechoslovakia ranks since 1952 continuously in the fifth place immediately after the German Federal Republic, the USA, the United Kingdom and Switzerland.

The Republic of India is a traditional market to which the Czechoslovak machine tool industry exports its products since many years. Since the end of the Second World War business connections between India and Czechoslovakia are on the upgrade. Exports of Czechoslovak metal-working machines to India are



Pressure die-casting machine Model CLP85.

rising continuously and the exports of last year were three times higher than those in 1951. The independent exhibitions of these machines with which the firm of STROJEXPORT, the exclusive exporters of Czechoslovak metal-working machines, take part in many international fairs and exhibitions, afford thus an excellent opportunity to the widest possible circle of prospective customers to get acquainted with the outstanding features of the machines. Hundreds of these machines working in a variety of Indian factories to the fullest satisfaction of the owners, are winning for the Czechoslovak metal-working machines an over growing number of customers.

HINDUSTAN MACHINE TOOL FACTORY TO MAKE MILLING MACHINES

The State-owned Hindustan Machine Tool Factory at Bangalore is to undertake, for the first time in India, the manufacture of milling machines of the latest improved type.

A contract for technical collaboration has been signed with Messrs. Fritz Werner of West Germany.

The factory will make six types of milling machines which will meet the demands of the Indian Railways, Defence factories and new industrial projects like steel plants, the heavy electrical equipment factory and the jet engine project. It is expected that the production of these machines will begin in about ten to twelve months from now.

The technical collaboration agreement provides for the training of 20 Indian technicians in the Berlin factory of Messrs. Fritz Werner. They will learn the technique of production of milling machines. The German collaborators will also send out to India five experts.

The Hindustan Machine Tool Factory, which is the only factory of its range and scope in India, produced for the second month in succession 24 high-speed precision lathes in December 1956. The factory has thus attained an annual rate of 300 lathes as against the original target of 57 lathes for the financial year 1956-57. Under the original programme, the target of 300 machine-tools per year was to be reached in 1959-60.

Technical collaboration agreements with other firms of repute for the manufacture of radial drills and circular grinders are under negotiation.

Treatment and Disposal of Liquid Radioactive Wastes

By C. Anandeswara Sastry and S. C. Pillai
Department of Biochemistry, Indian Institute of Science, Bangalore

WOLMAN and Gorman,[1] when discussing the future of atomic energy industry, observed that "the future growth of this industry from the developmental stage to that of applied use of its products may well hinge on its ability to find increasingly effective and reasonably economical methods of disposal of its hazardous waste products". These wastes are of particular concern because they are radioactive, and even at low concentrations the radiations emitted are dangerous to living tissue. In considering the treatment of these wastes Straub[2] recorded that "only time can modify radioactivity; no known physical, chemical or biological process can speed up or slow down the emanation of particles and rays from radioactive atoms". The time required to render the wastes innocuous varies with the 'half-life' period of the material. Thus the treatment of radioactive wastes, although they are similar to chemical wastes, has to differ from the treatment of other industrial wastes.

Before the liquid radioactive wastes can be discharged into a stream or river, precautions must be taken by the atomic energy installations to prevent the contamination of the water. Health physicists have worked out maximum permissible concentrations (MPC) for specific radioisotopes in water and air. The procedures for computing these tolerances and the latest MPC values under consideration by the Sub-Committee on Internal Dose of the National Radiation Protection Committee are also available.[2]

The literature on the subject of treatment and disposal of radioactive wastes is growing,[3-7] and the purpose of this article is to give a brief account of the nature and extent of production of liquid radioactive wastes, the health hazards and pollutional effects of the wastes, and of the possible methods of removal and disposal of the radioactive constituents.

NATURE AND QUANTITY OF WASTES

According to a recent publication of United States Atomic Energy Commission,[8] there are two major sources of radioactive wastes: (1) the production phases of the National Atomic Energy Programme, particularly the huge separation plants and nuclear reactors, and (2) the laboratories and hospitals where radioactive materials are used for research, medical and other purposes. In the explosion of an atomic bomb radioactive products may be released which may produce additional radioactive wastes. In addition to the radioactivity released in the explosion of an atomic bomb, the neutrons discharged would produce activity in other substances. This "induced activity" would vary depending primarily upon the elements in the vicinity of the explosion and the type of blast (air, sub-surface or water). Radioactive wastes may also result from the direct deposition of radioactive particles into watercourses.

Nuclear reactors and separation plants. The largest single source of radioactive liquid wastes is probably the water used for cooling reactors. It was reported that the volume of water diverted from the Columbia River to cool the Hanford reactors in U. S. A. would equal the water consumption of a city of over 1.5 million inhabitants.[9] In passing through the pile there is enough activity induced in the once circulated waters to make direct return of the wastes to the Columbia River inadvisable. Fuel elements removed from the pile are highly radioactive. Some portion of the isotopes are recovered from the liquid wastes by elaborate chemical methods and supplied for use in research, medicine and industry and the rest disposed as such.

Use of radioisotopes in research, medicine and industry. In recent years radioisotopes have been finding wide use in research, medicine and industry. A few instances may be mentioned here. Cobalt-60 has been used to detect flaws in cast valve bodies and welds, the thickness of coatings and materials, and for determining liquid level in tanks. Barium-140 has been used to detect changes in the grade of petroleum oil pumped through a common pipe line. Carbon-14 is a remarkable tracer of chemical reactions in research laboratories. Phosphorous-32 has been used as a tracer in agricultural and medical research. These and other isotopes have been used to check soil density at various depths, to study the dispersion of sewage effluents into bodies of water, to trace the flight of insects, and to locate sections of plugged pipes. Radium and uranium, which are naturally radioactive, are used in medicine, in industrial processes and in products such as static electricity eliminators, yellow fiesta ware, spark plugs, green and pink sun glasses, yellow caution lights and luminous dials. The amounts of radioactive materials used in tracer experiments and the wastes resulting from their discharge are small in volume and low in activity, being of the order of microcurie and millicurie (the curie is used as the standard unit in measuring the activity of a radioactive substance and is taken as equal to the substance that can produce 3.7×10^{10} disintegrations per second). Relatively larger quantities, both in volume and activity, may be discharged from hospitals[10] where radioisotopes are finding widespread use as therapeutic agents.

Nuclear power reactors. These have the greatest potential as a source of large amounts of radioactive wastes. Provision of satisfactory methods for the handling and disposal of these high level radioactive wastes, which will result from the processing of fuel elements taken from nuclear power reactors, is of paramount importance for the rapid development of this industry.

It is very difficult to forecast with any degree of certainty as to what the future holds for the development of atomic power. However, if such plants are put up and worked, the problem of the disposal of the wastes will, in all probability, become increasingly difficult. At the same time one must think in terms of an expanded use of radioactivity for peace time development which will, of necessity, result in handling of more and more radioactive wastes.

HEALTH HAZARDS AND POLLUTIONAL EFFECTS OF THE LIQUID WASTES

Radioactive waste may be hazardous in two ways, viz. by their chemical toxicity and radioactive emanation. So far as chemical toxicity is concerned, radioactive isotopes behave just like stable isotopes.

Radioactive materials are unstable and continuously disintegrate with the emmission of (1) Alpha particles, (2) Beta particles and (3) Gamma rays. The alpha particles damage mostly internally. They travel but a few inches in air but are stopped by the outer layer of skin. Beta particles can travel up to 10 feet in air and may penetrate as much as 0.33 inch of a tissue. Protection from these particles may be afforded by relatively thin sheets of plastic, glass and aluminium. These are again primarily an internal hazard to human beings. Gamma rays, like X-rays, pass through human body and other objects. They travel thousands of feet in air and are therefore a serious external hazard. Body damage by radiation is caused by cell ionization whether the type of radiation is by external or internal means. The damage by external radiation is immediate even though the evidence may be delayed for long periods of time. Internal radiation is insidious. When radioactive material is fixed in human tissue it is excreted very slowly and so remains long as a source of radiation within the individual. There is no known process to destroy the radioactive waste or methods to increase the rate of excretion or shield the individual from the internal radiation. The body damage caused by an individual radioisotope depends on the part of the body it seeks and its biological half-life period which determines whether the body elimination of the radioisotope would be faster or slower than absorption. For example, strontium is deposited on the bone structure. It has a long physical life of about 20 years and a slow rate of elimination, thus exposing bone tissues over an extended period of time.

As already indicated, the Sub-Committee on Permissible Internal Dose of the National Committee on Radiation Protection[11] have worked out the maximum permissible concentration of radioactive materials in air and water, on the basis of new biological, toxicological, and radiochemical evidences. An individual limit for each of a number of radioactive isotopes in air and water was recommended. The provisional levels of permissible concentration of unknown mixtures of radioactive isotopes in water and air, exclusive of natural background, are 100 micromicrocurie ($\mu\mu$c) of alpha or beta-gamma emitters per litre of water, 1 $\mu\mu$c of beta-gamma emitters per litre of air and 0.005 $\mu\mu$c of alpha emitters per litre of air. Information was also given for maximum permissible level of some individual radioisotopes. For example, the maximum permissible level for radium-226 in water is 40 $\mu\mu$c per litre and for strontium-90 and yttrium-90 is 800 $\mu\mu$c per litre.

METHODS OF TREATMENT OF LIQUID RADIOACTIVE WASTES

The specific method of treatment to be selected for a radioactive waste will depend upon the type, toxicity and radioactive concentration of the waste and may include physical, chemical, biological methods or a combination of all these methods. Physical methods include dilution, storage and evaporation. Chemical methods include removal of radioactive material from the liquid by absorption agents like activated carbon, ion exchange methods and finally precipitation, using chemical coagulants. No large scale uses of solvent extraction, electrolytic separation, differential volatility,

and electrodialysis seem to have been tried, although these techniques have been widely used as separating processes for isolating and recovering specific radio-isotopes from fission products and special irradiations. The biological methods include treatment on trickling filters, by activated sludge process, and concentration by algæ and other plankton forms.

In the disposal of radioactive wastes two principles are employed, viz. dilution and concentration or storage. In the case of highly radioactive wastes, dilution is not feasible and storage must be considered. Dilution method of disposal of liquid radioactive wastes is not safe in view of the observation made by Kochtitzy and Placak,[13] who reported that aquatic plants and organisms might concentrate radioactivity from the wastes which had been discharged into a stream, river or lake and the resulting concentration might be much higher than that of the environment in which the plants and organisms existed. This factor together with channeling action, thermal stratification, geological faults and transportation of deposited material in the stream may prevent adequate dispersion and dilution, resulting in high concentration of radioactivity at points remote from the sources of the wastes. Through fish which eat algæ and other plankton forms that concentrate radioactivity, human beings might receive radioactive isotopes.

If storage is to be selected for disposal of liquid wastes, reduction in bulk should be attempted because of high cost of such storage. Evaporation and other methods (chemical and biological) aim at reducing the bulk of the liquid waste to be dealt with.

Evaporation. Evaporation, even though costly, is quite useful in the concentration of large volumes of wastes containing small amounts of radioactivity. Evaporation will practically remove all radioactivity from liquid fraction and concentrate that activity in the solid residue or slurry.

McCullough[13] reported that evaporation was selected for concentrating dilute radioactive wastes at the Knolls Atomic Power Laboratory because it complied with the policy that no detectable amounts of radioactive material be discharged into the Mohawk River. A forced circulation type of evaporator system having a rated capacity of 500 gallons per hour was provided. It produced decontamination factors* of 10^7 from evaporator heel to condensate. It was estimated by that investigator that with two-shift operation at the design rate of 125,000 gallons per month the cost was $ 0.138 per gallon and with three-shift operation the average cost was $ 0.114 per gallon.

Browder[14] described the evaporation unit used at Oak Ridge National Laboratory which produced decontamination factors of 10^5 and volume reduction of about 60 to 1. The waste evaporator was described as a simple, pot-type, internal steam coil heated unit, housed in a shielded concrete building, having a design capacity of 300 gallons per hour. He reported that foaming was the only serious difficulty encountered during evaporation.

Chemical precipitation. Chemical precipitation is one of the most commonly used methods of treatment of many industrial wastes. Chemical precipitation was also found useful under certain conditions in the treatment of liquid radioactive wastes. Placak and Lyle[15] used lime and alum in the treatment of radioactive wastes. They found that alum coagulation was very effective in the removal of phosphorus-32, yttrium-90, yttrium-91, and cerium-144 (about 98% removal) and it was ineffective in the treatment of iodine-131, strontium-89, strontium-90 (only about 10% removal). Christenson *et al.*[16] observed that chemical precipitation was the simplest, cheapest and most efficient method in the removal of plutonium from laboratory waste when substantial amounts of organic complexing agents were absent from the radioactive waste. They reported that the amount of iron required for the treatment was nominal, 10 p. p. m. of ferric chloride with sufficient lime added to bring pH above 7. Complexing agents like citrate and phosphate, when present in the liquid waste, interfered with chemical coagulation processes; the interference could, however, be overcome by addition of calcium ions and increasing pH to about 12. Coagulation with ferric chloride produced effluents containing less than 70 counts per minute per litre of plutonium. About 20 gallons of wet sludge resulting in 3 lbs. of dry solids was produced from 1000 gallons of waste. Newell *et al.*[17] reported that laundry wastes containing plutonium could be treated by adding 300 p. p. m. of calcium chloride, 20 p. p. m. of sodium silicate and 60 p. p. m. of iron as ferric chloride; sodium hydroxide was added to raise the pH to 12. Sludge of 5.85% of the original volume of the waste was formed.

* Decontamination factor = Influent counts or dis/min/ml. / Effluent counts or dis/min/ml.

Lauderdale[18] proposed a new chemical coagulation technique in the treatment of radioactive wastes. He reported that phosphate used as sodium phosphate or potassium dihydrogen phosphate along with calcium hydroxide as alkaline agent was more effective for the coagulation than alum and ferric chloride or ferric hydroxide, as phosphate appeared to be the most common insoluble salt of the greatest number of isotopes encountered in mixed fission products. Summarising his studies with phosphate coagulation, Lauderdale reported that: (1) essentially all the cerium-144, yttrium-91 and zinc-65 were removed from mixed solution by phosphate precipitation; (2) approximately 10% of tungsten-185, 65% of antimony-124 and 95% of strontium-89 were removed by phosphate treatment; (3) efficiencies greater than 99% were obtained with a mixture of fission products by using clay in conjunction with the phosphate followed by sand filtration; and (4) the greatest efficiencies resulted at high pH (about 11.5) and with excess of phosphate (about 200 mg of coagulant per litre of the waste).

Ion exchange methods. With the newer high capacity synthetic ion exchange resins, many radioactive elements can be removed from large volumes of dilute wastes. The possibility of treating laboratory wastes of fairly low level activity by the ion exchange method was described by Ayres[19] who investigated various types of ion exchange resins under different conditions in the laboratory. It appears that both cation and anion exchange columns are necessary because amphoteric ions, such as tellurate and molybdate, are very inefficiently removed in a cation exchange column, but are quite readily removed in an anion exchange column. Mixed beds containing both cation and anion exchange resins will work as efficiently as the two bed system and may also have some slight advantage in operation. Where the contamination is very slight, simple cation exchange bed might be sufficient and a single bed would remove the most troublesome isotopes such as barium, strontium and zinc.

Lauderdale and Emmons[20] used a mixed and also monobed cation and anion resins to remove the residual activity after passage of mixed radioactive wastes through a column containing burnt clay, iron scrub and activated carbon. Swope and Anderson[21] reported that a sulphonic acid-type cation exchange resin could be used in the treatment of low level radioactive wastes. Although only 6,000 gallons of water containing 300 p. p. m. total solids and 85 p. p. m. of total hardness as calcium carbonate could be treated by one cu. ft. of the resin before attaining the point of break-through of total hardness, at least 260,000 gallons could be passed through per cu. ft. with 80% reduction of radioactivity.

After the waste passes through the ion exchange bed the activity is held in the resin; the waste can then be stored or further concentrated by ignition. Newell and Christenson[4] calculated that a laboratory producing 1000 gallons of waste per week having solid content of 2000 p. p. m. could be treated in a two bed ion exchange system giving a final waste volume of 0.6 cu. ft. The cost of this treatment would be $ 50 per week. It would be unwise to regenerate the resin because regeneration would result in another liquid waste containing the original radioactivity and would only present another problem.

The ion exchange capacity of soils and clays was also utilised in the treatment of radioactive wastes with some success. Lauderdale[2] used local kaolinitic and montmorrillonitic clays as absorbing agents for the removal of radioisotopes from a solution containing about 95% cesium and 4.5% ruthenium. Although the dosage of clay required was very high, removals of 80—85% were obtained. Jacobson and Overstreet[22] studied the removal of plutonium, strontium, zirconium, cerium and tellurium from liquid radioactive wastes by betonite clays.

Absorption agents. Studies on absorption agents by Christenson *et al.*[16] indicated that finely ground pumice, celite, tufa (a volcanic rock) and activated carbon were quite effective in removing plutonium. Activated carbon of the type used in water treatment was the most efficient of all absorption agents, but some practical operational difficulties were encountered. Plutonium could not be removed if some complexing agents such as citrates, phosphates, detergents, etc. were present in the waste. The efficiency could be improved by adjusting the pH of the solution. Unfortunately, in the case of activated carbon, effective pH is in the range of 2, and operating the plant under such conditions is expensive and difficult. However, the carbon has the advantage that it can be ignited after absorption of plutonium which will result in further concentration of plutonium.

Biological methods. Biological methods of treatment depend on the activity of some microorganisms. As the liquid radioactive wastes do not contain any food material for the microorganisms, organic matter should be added to the waste before it could be successfully treated by biological methods. The biological methods include treatment on trickling filters, activated sludge

process, and absorption by algae and other plankton forms.

Ruchhoft[23] showed by laboratory experiments that the α—activity of sewage containing 1.4 μg. plutonium per litre could be reduced by 96% in 24 hours by aeration with activated sludge. It was also reported that activated sludge showed a tolerance level of 0.001 microgram of plutonium per litre of sewage. Straub[24] recorded that about 60% of the activity of an evaporator waste slurry was removed by stirring it with activated sludge for 48 hours. He also reported that radioactive iodine was removed by the same process. Belcher[25] reported an investigation of the fate of certain radio-isotopes of medical interest, namely, sodium-24, iodine-13, phosphorus-32, bromine-82 and cobalt-60 during treatment of sewage by sedimentation, biological filtration and by the activated sludge process. It was found that only about 5% of the above substances was removed during sedimentation. The proportion removed during biological treatment was also small except for phosphorus-32 and cobalt-60; the proportions of these isotopes removed were 77% and 79% respectively during biological filtration, and 84% and 86% respectively during the activated sludge process. Eden *et al.*[26] investigated the uptake of radioisotopes iodine-131, strontium-90, cerium-144, and plutonium-239 by activated sludge. They observed that the uptake of radioisotopes was affected by factors such as pH and the concentration of other ions in solution.

In discussing the use of activated sludge in the removal of plutonium, Newell[27] pointed out that special precautions had to be taken in the handling of activated sludge because of the high concentration of radioactive constituents in the sludge. Unfiltered samples showed as high as 28% carry over of the radioactivity by the suspended matter in the effluent and hence the author suggested that sand filtration was necessary before discharge of the effluent to assure effectiveness of the process as a whole.

Trickling filters and slow sand filters were found to be quite useful in the treatment of radioactive wastes, as the volume of radioactive waste sludge produced would be minimal as compared to that produced by activated sludge or by chemical precipitation method. Newell *et al.*[17] showed that laundry effluent containing plutonium together with detergents and other non-radioactive contaminants could be treated by biological filtration with production of satisfactory effluents. Carter[28] studied the removal of carrier-free iodine-131 by low rate trickling filters and obtained 85% removal. Eden *et al.*[26] investigated the applicability of slow sand filters in the treatment of liquid radioactive wastes.

In a brief progress report on the Atomic Energy Commission's study of the relationship of algae to the disposal of radioactive wastes, Myers and Morgan[29] reported that green algae such as *Chlorella pyrenoidosa* might accumulate radioisotopes from aqueous environment under appropriate conditions. "To a first approximation the factors which control ionic uptake in the algae are those operable in the case of ion exchange in organic exchange resins. There are, however, deviations from typical ion exchange behaviour which are probably attributable to structural factors and metabolic requirement of algal cell". The possibility of using algal and other plankton forms in the treatment of radioactive wastes is still under examination.

Steel and Gloyna[30] reported that oxidation ponds would be of value in the treatment of certain low level radioactive wastes. They reported that decontamination factors of about 1.3 could be obtained in the case of aged mixed fission products for each five days of detention. This low factor could be increased by periodically removing a portion of the accumulated algae.

Sludge disposal. The methods indicated above have been employed to remove the redioactivity from the liquid fraction and to concentrate that activity in the solid phase or sludge produced. The disposal of this sludge is a very difficult problem. The materials can be stored in safe containers and buried deep underneath the soil or dumped into sea. The question of disposal of radioactive wastes into sea was discussed by Scott.[31] The use of concentrated radioactive waste as a liquid in making concrete blocks which might be dumped into sea or buried under soil was studied by Western.[32] But further work on the disposal of concentrated waste into sea or under soil has to be carried out before more definite information could be had on these aspects.

CONCLUSION

As in the case of all new industries, the development of atomic energy industry presents new problems to the sanitary chemist and engineer. In this case, the new problems are much more serious and difficult than those ordinarily encountered. The industry is likely to grow more rapidly in view of the great possibilities in regard to the utilisation of atomic energy for peaceful purposes; and closely associated with the progress of the industry is the problem of safe disposal of wastes containing radioactive materials. New situations, of course, call for new methods of approach, and it may be hoped that in due course more satisfactory methods of treatment and disposal of radioactive wastes will be devised by the combined efforts of the physicist, chemist, biologist and the engineer.

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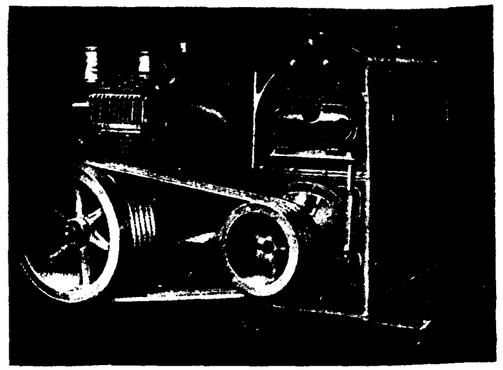
THE V-BELT DRIVE

By A. C. Bhattacharya, A. M. I. P. E.

ONE of the recent methods of power transmission is the V-Belt drive which has derived its name from the shape of the belts and pulley grooves.

V-Belts are essentially a development of the rope drive. It is difficult to trace their origin but as far as it is known they were introduced towards the end of the nineteenth century. Their early uses were mostly confined to motor cycle and motor car as cycle belts and fan and dynamo drives. From about 1920 they commenced to be used industrially.

The V-Belts are usually made of rubber and textile material, although they have been made of canvas plies impregnated and bonded together with balata. Such construction has rendered them extremely flexible enabling very small pulleys to be used.



A compressor being driven by means of V-Belt drive.

CONSTRUCTION DETAILS

In so far as the details of construction are concerned, a V-Belt has four component parts; the envelope, the inner or compression zone, the outer zone or tension layer and the central or neutral zone.

The load is carried entirely by a layer or layers of high tensile low-stretch endless cords. These cords are disposed in the neutral zone about the neutral axis, which is the horizontal line about two-thirds of the height from the base, at which there is no change in speed as the belt bends round the pulley. Most belts to-day are constructed either with multiple layers of light cords or a single layer of heavy cords for the strength member, depending upon the manufacturer's preference or convenience.

The envelope is specially meant for the protection of the belt from external wear, abrasion and weathering action. It is made of hard-wearing bias-cut fabric impregnated with rubber compound so that it can stretch itself when under tension.

The compression zone, which is essentially meant for giving support to the tension zone, is either of rubber compound or fabric cord and rubber. Responsible for giving the V-Belt body and shape, it passes on the load to the tension layer. The design of this zone is very important from the point of affording the maximum support to all the cords in the tension zone. Although much depends on the particular application on which the belt is to be used, usually the length dictates the use of rubber compound or fabric to go in the making of the compression zone. According to one manufacturer, the practice is to use rubber compound for V-Belts under 10′—0″ and fabric for those from 10′—0″ and over in lengths.

The tension layer is either of rubber compound or plies of bias-laid fabric impregnated with rubber. The fabric is folded in 1, 2 or 3 plies depending upon the manufacturer's preference and the type of belt.

RECENT IMPROVEMENTS

Among the recent improvements made in the field of development, the most important advancement has been the use of stronger materials than cotton for the tensile component of the belt.

Full advantage has been taken in this direction of the availability of synthetic fibres, some of which are being utilized for making these belts. The replacement of cotton cords by special high-tenacity rayon results in a product with twice the strength of a cotton reinforced belt, reduced stretch and much-improved

resistance to shock, overload and heat, in addition to having the ability to run successfully over smaller pulleys. A new nylon V-belt cord has also been developed to provide a stronger belt with increased life.

The steel cable V-Belts represents another development in the technique of V-belt manufacture. This has been possible by the development of methods of bonding rubber to steel. These belts are produced with a special three-ply cover and with carefully selected tension and compression sections of rubber over and under the endless steel load-carrying cables.

These belts have virtually no stretch over long periods of running and are the strongest ever produced, being able to run effectively at speeds down to 50 ft. per minute and upto as much as 5,000 ft. per minute. These belts in many cases are replacing chains and gears in power transmission. An important point which needs consideration in this connection is that pulleys used with steel cable V-belts should be perfect in angle and in surface finish in order to avoid abrasion on the belts. These V-belts are generally available in three cross sections: ½″×11/32″, 21/32″×7/16″ and 7/8″×17/32″ in sizes upto 100 ft. inside length.

V-BELT VERSUS FLAT BELT

Whether a flat belt or a V-belt is used will depend upon a number of factors. For convenience, adaptability, cheapness and little alteration or addition to equipment, the flat belt will be found to be most suitable and give good service with little or no trouble. Where there is the question of a crossed belt, or a right angle turn, or fast and loose pulleys or the belt has to be joined by a fastener or splice the flat belts are to be used.

For compactness, silence and smoothness in running, and freedom from slip, a V-belt drive is unexcelled. The absence of fasteners and joints in V-belts eliminates the weak point. The V-belt requires no dressing, as it does not operate by friction and requires nothing to preserve its flexibility.

The V-belt drive is free from vibration and requires less maintenance and lubrication. Not relying on friction to transmit power, it suffers little or no wear.

Space in a factory or Workshop is a very serious matter. The wedging action between the V-belt and the pulley groove enables large pulley ratios to be employed, ratios up to 8:1 being common with short-centre distances. The considerably reduced arc contact on the small pulley resultant in such driv enables their adoption where space is limited.

DRIVE DESIGN

Standard V-Belts are produced in five different siz —A, B, C, D and E having cross sections ½″×11/32 21/32″×7/16″; 7/8″×17/32″, 1¼″×¾″ and 1½″× respectively. Each of these has been designed for different range of horse powers as shown in the tal below :—

Belt Section :	*Width at top in inches :*	*H. P. range up to :*	*Recommended Min. Pitch Diameter of small pulley in inches :*	*Difference in Pitch Dia : and outside Dia : of Pulley in inches :*	*Approx : Difference in Outside and inside lengths of*
A	0.50	5	3.0	3/8	1.9(
B	0.66	25	5.0	1/2	2.7:
C	0.88	75	9.0	3/4	3.9:
D	1.25	100	12.0	7/8	4.7:
E	1.50	over 100	20.0	1.1/8	6.2:

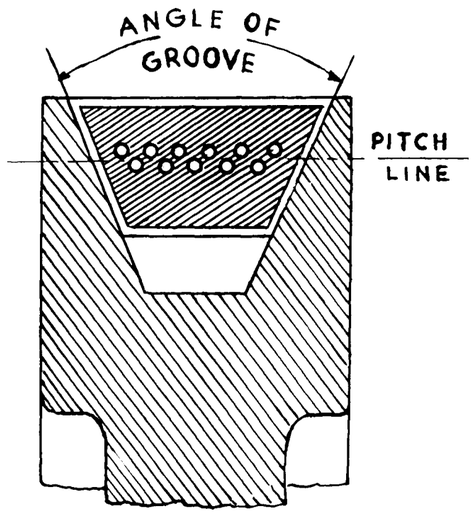


Fig. 1 The V-Belt.

The number and size of belts required for a V-belt drive depend upon the horse-power, speed ratio etc., and by using pulleys a few inches larger in diameter that the recommended minimum the belt speed can be increased and a less number of belts may suit the drive.

Based on the fact that the minimum centre distance recommended is not less than the diameters of the two pulleys added together, the length of the belt required should be calculated approximately, as V-belts are made in standard lengths, and more accurate results will be obtained by calculating the exact pulley centres when using, the selected belt.

$$B = 2A + \left(\frac{D+d}{2} \times \pi\right) = 2A + (D+d) \times 1.5$$

where B = approximate outside belt length in inches

D + d = pulley outside diameters in inches

A = Centre distances in inches.

The above formula is accurate when a ratio of 1 : 1 is to be used, but there will be a fractional difference when the ratio is increased. Normally this will not cause any serious degree of inaccuracy when designing a V-Belt drive, but if necessary it can be adjusted by adding to the above formula :

$$\frac{(D-d)^2}{4A}$$

This means that the complete formula for correct length of the V-Belt at pitch line

$$= 2A + (D+d) \times 1.5 + (D-d)^2$$

This formula can be solved for centre distance instead of belt length as follows :

$$A = \frac{X + \sqrt{X^2 - 32\,(D-d)^2}}{16}$$

where X = $4B - 6.28\,(D+d)$

D = outside dia of large pulley in inches.

d = outside dia of small pulley in inches.

To find the velocity of the V-belt in feet per minute, the following formula is applicable.

Velocity = Smaller pulley pitch diameter in inches

$\times$ r p m $\times$ 0.262

The smaller pulley pitch diameter may be found out by dividing the larger pulley pitch diameter in inches (Driving pulley) by the speed ratio, where,

$$\text{speed ratio} = \frac{\text{higher speed}}{\text{lower speed}}$$

The larger pulley diameter is found out by the following formula :—

P. D in inches = Recommended maximum V-belt velocity in feet per minute / 0.262 × R.P.M. (driving pulley)

The number of belts required can be calculated as follows :—

$$\frac{\text{H. P.}}{P \times A \times B}$$

where H. P. = maximum horse power to be transmitted

P = H. P. per belt at given velocity as given by belt suppliers

A = arc of contact correction factor

B = Service correction factor which varies according to the conditions under which the drive will operate.

The arc of contact may be determined by the following formula :—

$$\text{Arc of contact} = 180 - \frac{(D-d)\,60}{C}$$

where D = Diameter of the large pulley

d = Diameter of the small pulley

C = Centre distance

and the correction factor may be obtained from the following table

Arc of contact on the small pulley.	*Correction factors.*
180	1.00
170	.98
160	.95
150	.92
140	.89
130	.86
120	.82
110	.78
100	.74
90	.69

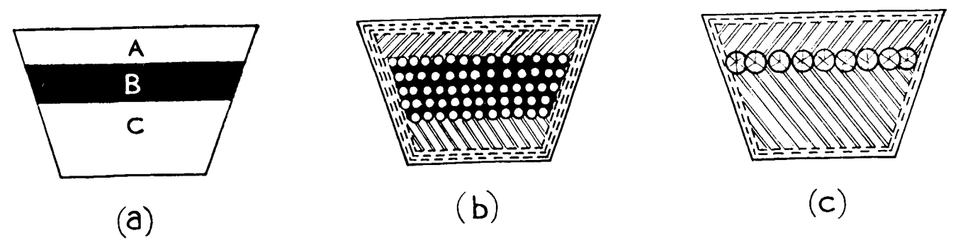


Fig. 2. Diagram showing stresses and sectional views of typical V-Belts.

a) When a V-belt bends round a pulley, the outer Zone A is in tension, the Central Zone B is neutral and the inner Zone C is in compression.

b) & c) Most V-belts are constructed according to either of these, viz : with multiple layers of light cords as shown in (b) or a single layer of heavy cords for the strength member as shown in (c).

As regards service correction factors, the following table is referred to :—

	Running hours per day		
	Upto 3	8–10	24
Steady loads	1.25	1. 0	0.80
Pulsating and uneven loads	1. 0	0.80	0.70
Heavy loads and high starting torques	0.70	0.60	0.50

INSTALLATION OF DRIVES

In installing the drive, the centres should be moved closer by the amount shown in the table below so that the belts may be placed in the pulley grooves by hand. Under no circumstances should V-belts be forced into the grooves. Also the centres should be adjustable over the calculated distance by an amount as shown in last column of the table because of possible stretch of belt and wear of belt and grooves. The table is reproduced with acknowledgement to Goodyear Tyre and Rubber Co.

Nominal lengths *	*Minimum Allowance below Standard Centre distance for application of belts*					*Minimum Allowance above Standard Centre distance for stretch and Wear*
	A	*B*	*C*	*D*	*E*	*All Sections*
26 to 38	¾″	1″				1″
38 to 60	¾	1	1½″			1½
60 to 90	¾	1¼	1½			2
90 to 120	1	1¼	1½			2½
120 to 158	1	1¼	1½	2″		3
158 to 195		1¼	2	2	2½	3½
195 to 240		1½	2	2	2½	4
240 to 270		2	2½	2½		4½
270 to 330		2	2½	3		5
330 to 420		2	2½	3		6
420 and over			3	3½		1.5% of belt length

* In each group the range is to, but not including the second length.

In a multi-belt drive, all the belts should be "matched" for length within small limits, the length being measured by mounting the belt on two pulleys under constant tension. This is necessary in order to equalize the tension taken by all the belts.

CORRECTION OF FAULTS IN V-BELT DRIVES

(i) *Abnormal Abrasion*—Check for foreign materials like metal particles, saw dust, grit, etc., and install drive guard by covering the top and/or side of the drive but allowing for adequate circulation of air and the escape of developed heat which is injurious to belts

(ii) *Loss in driven speed*—Adjust tension, check ratio of sheave diameters against ratio of R. P. M.

(iii) *Excessive Stretch*—This is caused by either overloading or internal breaks and these factors should be checked

(Continued on page 88)

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CEKOP

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Further information supplied on request also by:—

The Polish Commercial Counsellor's Office
42-44, Sunder Nagar,
NEW DELHI

The Trade Representation of the Polish People's Republic
28, Stephen Court, 18-A, Park Street, CALCUTTA
Jugal Kishore Bldg., 40-A, Peddar Road, BOMBAY-26

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SOLE EXPORTERS:

VARIMEX

Warsaw, 50/52, Wilcza Street, POLAND
P.O.B. 263, 264 : *Telegrams:* VARIMEX—WARSZAWA

Further information supplied on request also by:—

The Polish Commercial Counsellor's Office
42-44, Sunder Nagar,
NEW DELHI

The Trade Representation of the Polish People's Republic
28, Stephen Court, 18-A, Park Street, CALCUTTA
Jugal Kishore Bldg., 40-A, Peddar Road, BOMBAY-26

ALL ABOUT STANDARDS

SOFT SOLDER

The Indian Standards Institution has published the revised Indian Standard Specification for Soft-Solder (IS: 193—1956).

This standard was first issued as a tentative standard in 1950. Apart from providing for an additional grade of soft solder, the revised standard covers requirements with regard to manufacture, supplier's guarantee, sampling, chemical analysis and supply.

Nine grades of tin-lead and tin-antimony alloys commercially known as soft solder used in soldering electrical assemblies, machine soldering, blow pipe soldering, lead pipe jointing, etc. have been covered in the standard. Properties and typical uses of the nine grades are given in an Appendix for information.

HOT ROLLED STEEL STRIPS (BALING)

The Indian Standards Institution has published an Indian Standard Specification for Hot Rolled Steel Strips (Baling) (IS: 1029—1956).

This standard covers three grades, soft, medium and hard, of steel strips, popularly known as hoops, used for baling jute and cotton, in packing cases, and similar general purposes and it refers only to the finished product made in the mill. In view of the present manufacturing position in the country, this standard is confined to hot rolled strips of a maximum nominal thickness of 3.2 mm. (or 1/8 in.) and a maximum width of 150 mm. (or 6 in.).

(Continued from page 85)

(iv) *Cracks on side and base and hardening of belt envelope*—Check for heat and chemical fumes, avoid installation in a hot place and when unavoidable use special heat-resisting belts

(v) *Top side wear*—check for belt obstruction or turned over belt

(vi) *Unequal stretch*—unequal co-efficient of friction or broken cords are the probable causes which are to be checked

(vii) *Inability to transmit the rated load* Check for the evenness of the pulley grooves and correctness of the angle—Inspect individual grooves with a template to ensure that all the belts are running on the same pitch diameter and the last, check for the correctness of the drive design

(viii) *Belt soft or swelling*—check for rubber solvent or oil.

(ix) *Hot bearings* check for lubrication and correct tensioning

(x) Never use mixed belts, always replace with a complete new set and do not expose belts to oil in spray, liquid or paste form.

(xi) Ensure that the sheave shafts are parallel and there is correct alignment of sheave grooves.

The individual drive for all classes of machinery has now become a general practice. In connection with such drives, V-belt has proved not only the most efficient link, but at the same time the most economical method, permitting short centre distances and thus also saving the space. Independent tests have shown that V-belt drives are 98 per cent efficient. It is no wonder therefore that their use on industrial drives has gradually gained favour and they are now being widely used in place of flat belts in addition to being used in applications where any other type of belt would be unsuitable.

PRESSED STEEL TANKS

The Indian Standards Institution has circulated for comments to interested parties in the country a draft Indian Standard Specification for Pressed Steel Tanks. This Standard is one of a series of Indian Standards being published under the Steel Economy Programme of the ISI. Pressed Steel Tanks have come into use to a large extent because of their ease of erection, facility of transport, standard construction, ease in dismantling and construction. This standard lays down the requirements for the materials, fabrication, supply and erection of pressed steel rectangular tanks used for the storage of cold and hot water and certain other liquids and chemicals under pressure not greater than the static head corresponding to the depth of the tank.

In preparing this draft standard the committee of the ISI has taken into consideration the manufacturing and trade practices followed in the country.

Comments are invited on this draft Indian Standard by 26 July 1957 and interested parties can obtain copies of the draft from the Indian Standards Institution, 19, University Road, Delhi-8 or its Branch Offices at 40/40A Cawasji Patel Street, Fort, Bombay, and P. 11, Mission Row Extension, Calcutta.

EQUIPMENT FOR EYE AND FACE PROTECTION DURING WELDING

The Indian Standards Institution has circulated for eliciting comments, draft Indian Standard Specification for Equipment for Eye and Face Protection During Welding. Welding is becoming increasingly popular for fabrication and the use of welding calls for safety requirements. This Indian Standard covers requirements for protective equipment such as spectacles, goggles, face masks, helmets, hand shields and fixed shields for use in welding, cutting and similar operations designed to take protective filters and cover glasses. Recommendations on the use of the various types of equipment are also included.

An Indian Standard for protective filters and cover glasses is now under preparation.

In the preparation of this draft standard, the Sectional Committee kept in view the manufacturing and trade practices followed in the country in the field. Furthermore, due consideration has also been given to the need for co-ordination with standards being followed in other countries.

In view of the decision of the Government of India to introduce metric system of weights and measures in the country; equivalent values in metric units have also been included in the draft standard in addition to those in ft. lb. system.

Comments are invited on this draft standard by 30 July 1957 and all interested parties can obtain its copies from the Indian Standards Institution, 19, University Road, Civil Lines, Delhi-8, or its Branch Offices at 40/40A Cawasji Patel Street, Fort, Bombay and P-11, Mission Row Extension, Calcutta.

DICALCIUM PHOSPHATE

The Indian Standards Institution has just published an Indian Standard Specification for Dicalcium Phosphate (IS:1023—1956).

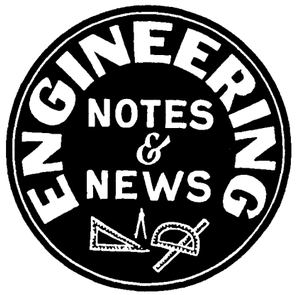
Phosphates in citrate soluble form are easily assimilated by the plant. This type of fertilizer will be of specific value to certain types of soils in which water soluble phosphates, as in the case of superphosphates, are less effective. This phosphate forms one of the semi-acidulated rock phosphate, which is being manufactured in the country in sufficiently large quantities.

This standard has been prepared by ISI's Heavy Chemicals (Inorganic) Sectional Committee, under the Chairmanship of Shri Madhav B. Bhagvat of Tata Chemicals Ltd., with the assistance of nominees of consumers, producers and government departments.

CAUSTIC SODA

Indian Standard Specification for Caustic Soda, Pure, (IS: 1021—1956) has just been published by the Indian Standards Institution. Caustic Soda, Pure is a basic raw material for a variety of chemical industries and is of particular importance in the production of rayon fibres where it is used as a coagulant. Rayon production is very sensitive to the impurities in the alkali which affect the quality of the final fibre produced. This grade of caustic soda will be suitable for rayon industry.

This standard has been prepared by ISI's Heavy Chemicals (Inorganic) Sectional Committee consisting of representatives from producers of caustic soda, consumers and various government organizations including Development Wing of the Ministry of Commerce and Industry.



U. K. TO TRAIN 300 INDIANS FOR DURGAPUR STEELWORKS

First Batch To Leave in June

Over the next four years, 300 Indian technicians who will fill key positions in the operation of the Durgapur steelworks, in West Bengal, will receive training in the United Kingdom. The first batch of 25 trainees has already been selected and is expected to leave for the United Kingdom in June. A further batch of 25 will follow shortly afterwards. This technical assistance has been made available by the U. K. under the Colombo Plan.

Arrangements for the training, which will be carried out in plants throughout the United Kingdom steel industry, will be made by the Commonwealth Relations Office in association with the British Iron & Steel Federation.

The training programme will be carefully phased so that Indian engineers will be available at an early date to assist in the construction of the steelworks at Durgapur, and a complete range of key men will be ready when the plant goes into operation. The trained men will fill posts down to and including the level of foreman. Each man will receive training lasting from six months to one year.

The Durgapur steelworks is being constructed and equipped by the Indian Steelworks Construction Co. Ltd.—a consortium of 13 British companies under an agreement signed with the Government of India last October.

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MOTORING NEWS

New Engine for Lightweight Cars

A leading British manufacturing company (Villiers Engineering Co.) has completed tests on a new two-stroke 250 cc twin-cylinder engine developed for lightweight three—and four-wheeled cars. This gives the "go-ahead" signal to several all-British miniature-car makers who had been held up for lack of a suitable engine, the manufacturers say.

Described as one of the most advanced engines of its kind, it incorporates a four-speed gearbox, an electric starter-generator, and a turbo-blower cooling system with twin fans, one on each side of the engine. These blow through an aluminium-alloy cowling which envelops the cylinder and directs a constant blast of cool air to the hottest parts of the engine.

Road tests have shown the engine to possess an extremely lively performance, with top speeds of 60 to 65 mph. and cruising speeds of 50 to 55 mph., the manufacturers say. They also claim that the twin silencers completely eliminate the familiar harsh two-stroke exhaust note without detracting from the performance of the unit.

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U. K. FIRM'S NOVEL METHOD OF DELIVERING CARS

The mass delivery of 40 brand-new Triumph sports cars was arranged by the Standard Motor Co. Ltd. at London Airport recently to 80 Americans as they alighted from a BOAC. airliner which brought them from the U. S. A. Orders for the cars Triumph T. R. 3s—had been placed by the visitors previously in the United States, and totalled $ 120,000.

The flight was organized by Standards, makers of the Triumph sports car. This is the first time in the comparatively recent history of European automobile exports to North America that such a method of mass delivery has been undertaken by a motor-car manufacturer.

After taking delivery of their cars, the Americans set off on a comprehensive three-week rally of England, France, Belgium, Germany, Austria, and Switzerland. When they return to their homes, some of the Americans will have covered a total distance of 20,000 miles.

The air flight, the rally, and the cars are all being paid for by the participants, but even so the event was heavily "oversubscribed".

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CARTRIDGE-OPERATED TOOLS CUT LABOUR COSTS

Simplicity and practicability are the keynotes of the cartridge-operated fixing tools manufactured by a British firm. The tools were on display at the British Industries Fair in Birmingham (May 6 to 17).

Operating independently of any outside source of power, these tools, by means of a small cartridge, drive hardened steel bolts and nails into concrete, steel, brickwork, and other materials. They incorporate three distinct safety devices—in addition to a special shield which prevents their being fired at an angle to the material—and an effective silencer.

It is claimed that the labour-saving qualities of the tools are so outstanding that, in some cases, the amount saved in labour alone, as compared with traditional methods, can cover the cost of a tool in 24 hrs.

*** *** ***

INTEREST IN GAS TURBINES GROWING

Use in Marine and Industrial Fields

Interest in gas turbines for use in the marine and industrial fields is steadily growing, as the claims of British designers and manufacturers are confirmed by operational experience.

A contract has been placed with a British engineering firm for two 5,700 kW, natural-gas-burning sets to be installed at Multan for the Pakistan Industrial Development Corporation.

Shipowners also are becoming more interested in the possibilities of gas-turbine engines for propulsion as a result of developments in linking gas turbines with free-piston gasifiers.

An example of this new departure is the re-fitting of a 10-year-old British India liner with four free-piston gasifiers. The gas delivered by them will be fed to a 4,000 shaft horsepower reversing gas turbine.

It is stated that the British India line wishes to obtain experience with this form of propulsion with a view to employing it in future new tonnage.

In general, it is stated by industrial power engineers that developing countries where oil and natural-gas deposits exist provide likely markets for gas turbines.

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U. K. POWER ENGINEERING FIRM'S ACTIVITIES IN INDIA

Plan to set up New Plant near Durgapur

Attention to requirements in oversea markets is a feature of the report by the chairman of Babcock & Wilcox Ltd., a leading British firm manufacturing land and marine steam-raising plants, presented at the company's 58th annual general meeting in London on May 30.

Saying that the firm's main activity is centred on the national programme for atomic-power stations, the report stresses the intention to maintain Britain's oversea business, both for conventional and atomic-energy power stations.

In this connexion, the chairman recalls that for over 50 years Babcock & Wilcox has maintained in India an organization for the sale of its products and for their installation and servicing, both in the electric-supply undertakings of great centres of population and those indigenous industries which are of major importance to India's economy.

"As a result of the Government of India's plans for rapid and large-scale industrialization", the chairman, Mr. Lionel Fraser, adds, "it has become evident that we should establish a centre for the manufacture of boiler and ancillary products in this country. As a result of negotiations begun last year, a new company is to be formed in partnership with Vickers Ltd. and Associated Cement Companies Ltd., of Bombay, to set up a large works in the Durgapur area of West Bengal for the construction of a variety of heavy-engineering products, including Babcock & Wilcox products of all kinds and cement making machinery".

WORLDWIDE ORGANIZATION

Amplifying the claim that "Babcock spans the world", the report states that the firm is a worldwide organization represented in 50 countries.

Apart from its manifold activities associated with steam raising plant, Babcock & Wilcox has gained much practical experience in production through important orders undertaken for the Calder Hall and Chapel Cross atomic-energy power stations.

Commenting on the chairman's report, the *Financial Times* (May 9) in an editorial says, in reference to the decision to set up a boilermaking plant in India, the success of the decision to remain in the Japanese market, and last year's record sales by the company's Australian subsidiary. "The expansion possibilities in these oversea markets may well prove even greater than in this country and Western Europe, and Babcock & Wilcox is now not far from the point where half its orders are for Commonwealth and foreign customers".

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NEW INDIAN AGENCY FOR BRITISH FIRM

The engineering interests of the British firm Birlec Ltd. will, in future, be handled in India by Associated Electrical Industries (India) Ltd., with headquarters in Calcutta and branches in many other towns. This has been decided after a visit to India by Mr. George P. Tinker, managing director of Birlec, with the object of reviewing agency arrangements.

The importance of India and Pakistan as markets for Birlec equipment can be judged by the fact that since 1946 this Birmingham firm has done business worth more than £1,000,000 in the sub-continent. Twenty-two arc melting furnaces have been supplied, and orders in hand for the area are worth over £500,000.

During his trip, which was his third to India Mr. Tinker visited Government departments in New Delhi concerned with industrial development, and many firms using Birlec furnaces. These installations are mostly arc melting furnaces, but they include a five-ton mains frequency coreless induction holding furnace supplied to the Tata Locomotive and Engineering works at Jamshedpur, the first unit of its type to be exported from Britain to India.

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EXECUTIVE OF U. K. ENGINEERING FIRM VISITING INDIA

A noted executive of a British firm of heavy-engineering electrical-equipment manufacturers visited India this month. He is Mr. George P. Tinker, managing director of Birlec Ltd., electric-furnace producers, of Birmingham.

The object of Mr. Tinker's visit is to establish an agency for Birlec interests in India, since the market for electric melting furnaces is rapidly increasing, particularly for use in steel production.

During November 1955 a five-ton Birlec mains frequency coreless induction holding furnace was shipped from England to the Tata Locomotive & Engineering works at Jamshedpur. Designed to be installed at the company's mechanized alloy-iron foundry, the furnace completes a large consignment including two Birlec three-ton furnaces and two seven-ton arc furnaces, together with two laboratory-size furnaces.

It is of interest that since 1946 Birlec Ltd. has been commissioned by various Indian companies to build a total of 22 arc melting-furnaces in a wide range of capacities. One of these recently ordered is for a second four-ton furnace for the Indian Iron & Steel Co. This furnace gives an output of approximately two tons per hour, and the furnace has a shell diameter of eight feet.

Mr. Tinker's trip will be his third business visit to India. His previous journeys were in 1949 and 1946.

Mr. Tinker is a Fellow of the Institute of Metals and of the Institute of Directors. He has been managing director of Birlec Ltd. since 1950, having first been appointed director in 1946.

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FLAME PROOF ELECTRIC FORK-LIFT TRUCK

A completely flame proof electric fork-lift truck for the mechanical handling of goods made its debut at this year's British Industries Fair in Birmingham (Castle Bromwich, May 6 to 17).

The truck has all its electrical components within robust flame proof enclosures. External wiring between all electrical components consists of mineral-insulated, copper-clad cables.

The truck has a capacity of 4,000 lb. at a 20 in load centre.

Also being shown for the first time by the same manufacturers is a load clamp designed to introduce a new technique of unit load handling without pallets. It can be used in the handling of cartons, boxes, cases, or crates.

Another development on show by the same firm is a stabilizing clamp designed to prevent "load-slip" during transportation. The stabilizing clamp secures to a support frame attached to the fork carriage, and is hydraulically operated to hold the load on the forks. Provision is made for adjustment to suit load dimensions, and an anti-bounce device cushions shocks over rough road surfaces.

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U. K. FIRMS DESIGN NEW-TYPE MOTOR-RICKSHA

A new type of motor-ricksha designed jointly by two British firms is attracting considerable interest at the Casablanca International Trade Fair, which opened on May 4.

The ricksha is a three-wheeler employing a motor-cycle-type front end. It has a 350 cc overhead-valve, single-cylinder engine, a four-speed gearbox, and shaft drive to a conventional car-type back axle. It has telescopic suspension at the front and leaf springs at the rear.

The machine, which is being exhibited in three forms—as a chassis, a commercial truck, and a six-seater ricksha—is intended to carry a load of half a ton, and possesses an adequate performance while achieving this. The two manufacturers have produced the vehicle especially to suit conditions in India, Pakistan, Malaya, Viet-Nam, Cambodia, Laos, Hong Kong, and North, South and Central Africa.

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U. K. SALES MANAGER TO VISIT INDIA

Mr. R. E. Rutherford, oversea sales and service liaison representative of Bryce Berger Ltd., fuel-injection engineers, of Staines, Middlesex, will visit India in July in the course of a four-month tour of Eastern countries. Other countries to be visited by Mr. Rutherford, who is already in Australia, are New Zealand, Malaya, Thailand, Pakistan, and Ceylon.

Mr. Rutherford's tour is planned to maintain close liaison between the company and its agents and customers. It is the company's policy to keep service facilities overseas up to date by visits of company representatives who can give the latest information on developments and, at the same time, gain first-hand knowledge of local conditions.

Mr. Rutherford arrives in Malaya on June 14, and will be in Thailand from June 17 to 24. He then returns to Malaya, where he will stay from June 25 to July 6. His tour of India, Pakistan, and Ceylon will be from July 6 to 31.

NON-FERROUS CASTING PLANT

It is reported that the Electrical Manufacturing Company of Calcutta has set up a modern non-ferrous casting plant for manufacturing complete range of conductor accessories etc. required on transmission and distribution lines. Overhead equipment for railway electrification is also licensed to be manufactured by the Company. This is being made from various alloy metals in technical collaboration with French experts. The non-ferrous foundry reportedly employs most up-to-date techniques like gravity diecasting and pressure diecasting.

NEW STEEL TUBE MILL OPENED

A Rs. 1.6 crore steel tube mill was declared open last week at Madras by the Governor of Mysore. The mill is designed, according to a report, to manufacture annually 12 million feet of electric resistance welded steel tubes primarily for the cycle industry, but later on for tubular furniture, transformers, boilers and buses as well. The tubes are now made of imported Sheffield steel, but the factory is expected to make use of Jamshedpur steel when a suitable variety becomes available soon.

TROMBAY POWER PROJECTS

A long-term loan of $ 9.8 million has been sanctioned by the World Bank to the Tata Hydro-Electric group of companies to finance the expansion of their thermal electrical power plant at Trombay. This is the second loan to be sanctioned by the World Bank to the Tata group for the same purpose; the first loan for $ 16.2 million, sanctioned in 1954, assisted the group in constructing a plant with two generating sets, having a combined maximum capacity of 125,000 kw. The present loan of $ 9.8 million will help the group to meet the foreign exchange cost of a third unit, with a maximum capacity of 62,500 kw. The total cost of the plant is estimated at $ 14 million, of which $ 4.2 million represents expenditure in rupees. This sum will be found by the companies from their own resources. The World Bank's loan of $ 9.8 million will be utilised to finance the import of boiler plant, turbine generator and condensing equipment, accessory electrical equipment and transmission extension, coal handling, coal crushing and ash disposal equipment.

NAMES IN THE NEWS

SIR NORMAN KIPPING

Sir Norman Kipping, Director-General of the Federation of the British Industries (FBI), during his brief stay in India visited several Industrial Projects in India and also had detailed discussions with the Government of India high-ranking Officials, Ministers, prominent businessmen and industrialists.

Sir Norman is of the view that India particularly needs heavy engineering goods for her basic industries. He believes that Britain could increase her trade in India, which is already of the United Kingdom's largest markets. Balance of payments is India's main difficulty and while Britain, he believes, is not in a position to give her India the kind of credit she would like, yet a satisfactory compromise could be reached.

Sir Norman's report on his visit to India, Iraq and the detailed discussions he had in these countries on several engineering and industrial projects would be of great interest to Britain and the countries concerned.

Sir Norman who is 55, was educated at the University College School and the University of London. Beginning his career as a Postal Engineer he was for about five years Transmission Engineer with the International Western Electric Company and then for about 15 years served in various capacities with different organisations, the last assignment being with the Standard Telephone and Cables Ltd.

In 1942 he was appointed head of the Regional Division in the Wartime Ministry of Production and in 1945 became Under-Secretary at the Board of Trade.

He has been Director-General of the FBI since 1946 and was Joint Secretary of the Anglo-American Council on Productivity from 1948 to 1952. He is a member of the National Production Advisory Council on Industry, the Dollar Exports Council, the British Productivity Council, and various departmental committees. He was knighted in 1946, and in 1948 Denmark made him a Commander (Second Class), of its Order of Dannebrog. Last year, he visited Finland, West Asia, Canada and the United States.

The Federation of British Industries was founded in 1916 and incorporated by Royal Charter in 1923 for the encouragement, promotion and protection of British Industries of all kinds. Some 7,500 individual firms and almost 300 trade associations are members of the Federation.

The Federation is not connected with any political party. All aspects of industrial activity come within its scope except employer-worker relations which are the province of the British Employers' Confederation. The FBI has no price-fixing activities.

THE AUSTRALIAN TRADE MISSION TO INDIA

India and Australia are important trading partners. During the year ended 31st March, 1956, Australia was India's fourth best customer, while, for approximately the same period, India ranked tenth in Australia's overseas markets.

The wool packs and corn and flour sacks which Australia imports from India play an important role in the marketing of her primary products. Other notable imports are tea, cotton, and cotton piecegoods, hessian and vegetable oils.

The requirement of India's Five Year Plans are producing changes in the pattern of her imports from Australia. There is a greatly reduced demand for wheat as India increases her grain production and avails herself of the agricultural surpluses of other lands.

On the other hand, the remarkable Industrial progress which is taking place in India has created a strong demand for metals, agricultural equipment, railway rolling stock and locomotives, windmills, electric cables, electronic equipment, automotive parts, plastics and for the many other products of Australia's heavy and light industries whose products are up to world standard and embody the most modern concepts of design and performance

Australian milk products and wool tops are also finding increasing markets in India. Australia is well able to supply a wide range of commodities suited to the demands of the planned industrial development of India's economy.

The Australian Trade Mission to India affords an excellent opportunity to the businessmen of both nations to get together for a discussion of their needs and future prospects.

Leader of the Mission is Mr. John G. Hurley, President of the New South Wales Chamber of Manufacturers and immediate past President of the Associated Chambers of Manufactures of Australia, and Chairman of the Standing Committee on Productivity of the Ministry of Labour Advisory Council.

Mr. Hurley, who is Joint Managing Director of Berlei Ltd., of Sydney, recently attended a New Zealand tariff enquiry to give evidence on behalf of Australian manufacturers.

Other members of the delegation are Mr. J. W. Shannon, Manager of the Bank's Adelaide Office (The National Bank of Australasia Ltd.), Mr. L. H. Dorman, Assistant General Manager, The Australian Wheat Board, Mr. John Gully, Representative of Brown and Dureau Ltd., Mr. W. C. Schutt, Chief Representative of Qantas Empire Airways Ltd., Mr. A. E. Dash, Assistant Manager of Commonwealth Trading Bank of Australia, Mr. E. G. Roberts, Representative of the Australian Dairy Produce Board, Mr. W. R. Greig, Representative of Chrysler Australia Ltd., Mr. G. C. Clarke, Chief of The Commercial Bank of Australia Ltd., Mr. J. Tomasetti, of Tomasetti and Son Pty., Ltd., Mr. D. A. Funston, Export Manager, Moulded Products (Australasia) Ltd., Mr. A. Menhinick, Chief Executive of Automotive Parts Division of Repco Ltd., Mr. E. C. Cameron of Gordon Bros. Pty., Ltd., Mr. L. R. K. Miller of Waters Trading Co. Pty., Ltd., Mr. C. H. Jeeves of Radio and Communications Division of Amalgamated Wireless (Australasia) Ltd., Mr. John D. Milne, Manager of the Internation Division of Australia and New Zealand Bank Ltd., Mr. K. Hutchence of Guthrie and Co. (Australia) Pty., Ltd., Mr. J. R. R. King, Director of F. W. Hughes Pty., Ltd., Mr. H W. Muter of the Commonwealth Engineering Co., Ltd., Mr. G. R. Lempriere of Lempriere Australia Pty., Ltd., Mr. J. A Robinson of Radco Boilers Pty., Ltd., Mr. M. G. Selios of Victor Dekyvere and Co., Mr. J. M. Ratcliffe of Cement-Making Morag Pty., Ltd., Mr. V. E. England of Fowler Constructions Ltd., Mr. B. A. Veitch of T. S. Skillman & Co., Pty., Ltd., Mr T. G. Salgo of T. G. Salgo & Co., Mr. W. Noad of Australian National Industries Ltd., Mr. A. K. Hextall of R. Allen & Co., Pty., Ltd., Mr. J. A. A. Hay of Bank of New South Wales.

COMPANY NEWS

INAUGURATION OF THE COVERED ALUMINIUM CONDUCTOR PLANT OF THE ALUMINIUM INDUSTRIES LTD., KUNDARA—26th April, 1957

THE seventh Factory Day Celebrations of the Aluminium Industries Ltd., Kundara (Kerala)—India's largest producers of aluminium rods, aluminium conductors and accessories—were held this year also as a two-day carnival with the usual mirth, festivities and programmes of entertainment. One significant feature of this year's celebrations was the

Shri V. C. G. Nayar.

opening of the new Covered Aluminium Conductors Plant—the first of the kind in India—by Shri K. P. Sreedharan Nayar, Chairman, Kerala Electricity Board, on 26th April, 57.

Welcoming the gathering to the function Shri V. C. G. Nayar, General Manager, referred to the several-fold growth of the Alind since its inception in 1950 and said that Alind is now able to supply the lion's share of the country's requirements of aluminium conductors and accessories, and that "our capacity to meet the increasing demands will soon be even more augmented by the completion of the new project of this company at Hirakud in Orissa State, where construction has already started." "The new plant which is being inaugurated today", Shri Nayar said, "is most significant from the technical point of view and marks the fruitful culmination of major technological advances in the application of aluminium in the electrical field. The entry today of aluminium into the Covered conductor field in this country is a forerunner of many more conquests into the vast electrical industry areas now monopolised by copper. The fact that Alind is pioneering this line should be a guarantee that steady progress will be made in exploiting fresher fields of aluminium applications in the electricity industry in this country. While pursuing this goal, we shall continue to uphold the ideals of Quality FIRST IN THE PRODUCT AND SERVICE FIRST TO THE CUSTOMER".

Mr. H. K. Ramaswami, Deputy Chief Engineer of the South Madras Electric Supply Corporation Ltd., Trichy, who spoke next recalled his close association with the project since its planning stages and observed that with the sample conductor he has received, he has found that aluminium conductors for use in HSOS and indoor wiring posed no technical problems at all and the pioneering zeal of Alind could make the use of aluminium conductors for indoor wiring and house-service connections even more popular in this country, and also save precious foreign exchange in the present-day economy of the country. He hoped that Alind would soon develop manufacture of polythene insulated aluminium underground cables and also produce aluminium wires for motor-winding etc.

Mr. Charles G. Gorton, a cable consultant of eminence who was responsible for designing and installing the plant and training personnel addressing the gathering expressed his sincere hope that Alind's reputation will be maintained and the product in the new plant will be "better than the best".

The Director of the firm, Mr. B. V. D. Menon, in his address gave financial details of the project. Speaking about the productivity of the plant he said that Alind had expanded in the last seven years eight-fold and that so far 75,000 miles of ACSR and all aluminium conductors valued approximately Rs. 10.5 crores had been produced which resulted in the cumulative savings of India's foreign exchange to the tune of 5 crores of rupees. He added that Alind's installed capacity was about 10,000 tons of conductors valued at approximately Rs. 4/5 crores which meant an annual saving of foreign exchange of about Rs. 1.5 crores.

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THE DUNLOP RUBBER CO. (INDIA) LTD.

Annual General Meeting held in Calcutta

Speaking at the annual general meeting of the Dunlop Rubber Co. (India) Ltd., Mr. John Luckham, Managing Director, announced the appointment of Sardar H. S. Malik (till recently Indian Ambassador to France) to the Board.

Dealing with the trading aspects of the firm during the year under review Mr. Luckham said that the factory was working to full capacity throughout the year and new records of output were achieved. Nevertheless the Company was unable to meet the demand for all of the products and the shortage of Giant and Cycle Tyres and Cycle Rims necessitated the Government granting import licences for these products to alleviate the situation. However, he said, plans for augmenting production in these respects had already been formulated and were being executed to meet the shortage to the possible extent.

Once again, he said, distribution of the Company's products was adversely affected due to the shortage of railway wagons. Many pleas have been made from both the public and private sectors for serious action to be taken to improve the situation and it is to be hoped that this important problem will receive the attention it deserves.

Total sales in value were 12-½% higher than in 1955, but with the lower level of selling prices prevailing throughout 1956, the ratio of profit to turnover declined from 3.6% to 3.2% after taxation. This exceedingly modest profit percentage provides, I think, a good measure of our service to the community.

"We have continued to receive the full benefits of the Dunlop world-wide research activities and many improvements have been put into effect during the year. Last year my predecessor announced the introduction of the new Dunlop Roadster Giant Tyre and it is with great pleasure that I am able to tell you that this has been extremely successful and has proved ideal for most conditions. This new tyre, combined with the ever popular Dunlop Trakmaster Giant Tyre, provides users with an ideal selection to choose from to cover the different types of service conditions which are found in this country. Car Tyre performence continues to be excellent and we have retained our premier position in the market.

Other important points from Mr. Luckham's review of the trade are:

1. The Company was unable to meet the rapidly increasing demand of the Bicycle Industry in respect of Cycle Tyres, Rims and that imports to some extent would be necessary to fill the gap.
2. Substantial increases in sales of Industrial Rubber Products range.
3. The Company was taking active steps to increase the production of Conveyor Belting and Dunlopillo Latex Foam Cushions.
4. Considerable progress was registered in the Chemical Plant lining.
5. Permission of the Government of India has been obtained by the Company to start another Unit at Madras for the manufacture of tyres.
6. The raw material supply position with the exception of crude rubber was generally satisfactory.
7. Excellent employer-employee relation were maintained during the year and several amenities were provided by the Company to their Staff.

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INDIAN ALUMINIUM COMPANY LTD.

Speaking at the annual general meeting in Calcutta of the firm Mr. K. C. Mahindra, Chairman, said that the year under review had been eventful from the Company's point of view. Sales and profits in 1956 attained new heights, the programme for fresh issues of capital was successfully completed, and new patterns, long under preparation, emerged in sales of the Company's products and in the field of Labour relations.

Other salient points from the Chairman's address are :—

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1. In spite of the present day trend in fresh investments, the Company has been able to raise substantial funds on the Indian Market.

2. The canadian shareholder, Aluminium Limited, subscribed one-half of the new capital issues, and this subscription assumed special significance today in the light of the foreign exchange position of the country.

3. Excellent Employer-Employee relations and the comprehensive agreements negotiated with the Labour Unions at the Company's Works at Belur, Muri and Alupuram, which will ensure Industrial Peace.

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GUEST, KEEN, WILLIAMS, LIMITED

Statement by the Managing Director, Mr. H. M. L. Williams.

Speaking at the annual General Meeting of the firm in Calcutta recently the Managing Director, Mr. H. M. L. Williams announced the appointments to the Board of two veterans in public and business affairs, Sir A. Ramaswami Mudaliar and Mr. K. C. Mahindra.

Dealing with trading profits to the firm during the year under review he gave the following figures:—

Invoiced Sales	Rs. 7,91,30,588/-
Surplus before taxation	Rs. 1,52,76,593/-
Provision for taxation on profits	Rs. 69,60,774/-

Speaking about the production trends, the Managing Director said that during the year under review, both Calcutta and Bhandup Works had full order Books in almost all departments and helped by improved supplies of steel imports, were able to achieve greater outturns compared to the previous year. Also of immense benefit was the delivery of rods from their Associated Company, Guest, Keen & Nettlefods (South Wales) Ltd., meeting the needs of the Bhandup Works throughout the year. Furthermore, he said, the firm was fortunate enough in being assisted from the same source by the supply of all the smaller size rods for Calcutta Works, enabling our own 8" Rolling Mill to concentrate on longer runs of more profitable sections. Our Calcutta Works, he continued, as a whole achieved a record output of 45,943 Tons.

The production of railway track sleepers was generally maintained at a good level due to availability of imported sleeper bar. Railway Switches and Crossings produced were the highest on record, as also were forgings for the wagon builders and the specialised Permanent Way Fitting, P. & M. Anchors and Mills Loose Jaws, of which the Company has been the pioneering India.

The Company's Bolt & Nut Works achieved a record output, but due to the very high costs of this specialised plant a commensurate return on investment in this section is dependent on high working efficiency, and this cannot be achieved until sufficient steel is available to operate the full plant on a two shift basis.

The 5-ton Electric Steel Melting Furnace at Calcutta Works with a record output of 7,200 ingot tons during the year 1956 has again fully justified its existence. This furnace is making medium high carbon and alloy steels, utilising as its main raw material low-value steel scrap from the Company's manufacturing sections.

Bhandup Works, which made its first wood screw as recently as the autumn of 1953, also achieved a record output.

The introduction of Hypodermic Needles was also made but although these needles are manufactured to the same standards of quality as the best imported article, it will take time to overcome a certain amount of consumer resistance. However, this will be a popular manufacture and Hypodermic Needles should record a more satisfactory sale and increased income to the firm.

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AUTOMOBILE PRODUCTS OF INDIA LTD.

Speech of The Chairman, Mr. M. A. Chidambaram.

Speaking at the annual general meeting of the Automobile products of India Ltd., held recently in Bombay, the Chairman, Mr. M. A. Chidambaram revealed that the firm had, during the year under review, earned a net profit of Rs. 4,73,393.

Dealing with expansion plans the Chairman said that the Company's efforts to extend its activity had met with considerable success and all the Schemes were progressing on sound lines. The machinery for Brake Lining Plant was received towards the end of 1955 and was installed and trial operations commenced towards

the close of the financial year. Normal production was established from the beginning of the new financial year and as regards quality, the Product has been found comparable in every respect with the American product. Selling arrangements have been concluded with Messrs. Firestone Tyre & Rubber Co. of India Private Ltd., and our experience in the few months indicates that we will have a rising volume of demand and a substantial share of the market.

Speaking about the production of Lambrettas, Mr. Chidambaram said that the marketing and distribution of the Lambretta Motor Scooter had been supported by a well-planned advertising and sales promotion programme. This, he said, helped us to establish a steady and rising demand for the vehicle, which has now been recognised in India as a very economical and reliable form of transport for the individual, for the small trader and for the large commercial and industrial concerns. Continuing the Chairman said:

"We had indicated to the Government that we would proceed to implement our phased manufacture once we establish a steady demand for the new product in the country at any rate not later than the end of the 1st year. Orders have been placed through our Associates in Milan for all the machine tools, jigs, small, standard and special tools to implement the first phase of our approved manufacturing programme. Shipments of the above machine tools etc., have started and all the equipment will be in India in good time. We have also concluded an arrangement with *Messrs. Kirloskar Oil Engines Limited*, to manufacture the Engine and Transmission Unit on a 5-year phased programme period. By this arrangement, a considerable responsibility, which should have normally rested on the Company, has been shared with *Messrs. Kirloskar Oil Engines Ltd.*, which is a well-known firm with considerable experience in the manufacture of Engines, Machine Tools and other similar products. This arrangement has the Government's concurrence.

"The Assembly Line and Test House capable of assembling and testing 20 engines per day have been installed during the year. We have been negotiating with two Primary Manufacturers of Commercial Vehicles for fitment of Meadows 330 Engines as original equipment. One of them have accepted the Engine and Vehicles fitted with our Engines are currently under test with the other. Agreements will be entered into with the primary manufacturers as soon as the tests are over and the engines approved by them."

The Chairman expressed gratitude to the Members of the Tariff Commission who gave the firm's Executives a patient hearing and sympathetic consideration of all the points they had placed before them in connection with the problems of the Industry and hoped that the recommendation of the Tariff Commission should go a long way in establishing the complete manufacture of the commercial vehicle in India within the Second Five-Year-Plan.

ILMENITE AND URANIUM DEPOSITS

It is reported that big deposits of radio active minerals have been located somewhere in N. E. India by the Atomic Energy Department of the Government of India. The deposits reportedly have over 3.3 million tons of thorium of concentration of about 10 per cent and 10,000 tons of uranium of concentration of 0.3 to 0.4 per cent. The deposit, according to this report, also contains about 80 million tons of ilmenite which is considered more important than the famous beach deposits of Travancore, hitherto recognised as one of the world's richest deposits.

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NEIVELI PROJECT

According to an information, mining equipment for the integrated lignite project at Neiveli is expected to be delivered by April and mining work is expected to begin in May, this year. It may be mentioned that the cost of the equipment is estimated at about Rs. 17 crores. Besides this, order for conventional and specialised equipment valued at about Rs. 5.5 crores has also been placed.

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HINDUSTHAN CABLES

According to an official statement, it is learnt that the Hindusthan Cables factory manufactured 610 miles of cables during the year 1956 compared with 386 miles of cables manufactured during 1955. It is now proposed to work double shifts in the factory in order to manufacture 1,000 miles of cables per annum to meet the increased demands. It is also proposed to manufacture 300 units of co-axial cables per annum for the Posts and Telegraphs Department.

SUPPLY OF STEEL AND CEMENT TO COAL INDUSTRY

During 1956—57, the Government of India have allocated to the private sector in the coal industry steel amounting to 22,077 tons, of which 14,865 tons are for maintenance of existing works and 7,212 tons for development schemes. These allocations are against the demand of the sector for 19,007 tons of steel for maintenance and 18,556 tons for development. During the same period the State collieries have been allocated a total of 600 tons of steel.

In 1955—56, the private sector secured an over-all allocation of 22,020 tons of steel, of which 14,430 tons were for maintenance and 7,590 tons for development, as against the over-all demand of 29,522 tons, of which 17,943 tons were for maintenance and 11,579 tons for development. The allocation to the State Collieries during the second half of 1955-56 was 702 tons. In the first half of the year collieries in the public sector drew their steel requirements from the Eastern Railway quota.

As regards cement, during 1956, the Government of India allocated 9,169 tons for the private sector and 6,201 tons for the public sector. The quota allocated to the State collieries includes a special allocation of 2,726 tons for the requirements of the washery plant at Bokaro. These allocations are against the demand of 42,800 tons by the private sector and 12,100 tons by the State collieries.

The disparity between the demands and allocations of steel and cement to the public and private sectors is attributable to basic shortages of these commodities. The requirements of the State collieries are determined mainly with reference to the fact that development of coal mining in the public sector is of comparatively recent origin.

In respect of securing allocations of steel and cement for the industry the procedure followed hitherto has been that the demands of both the State collieries and the private sector are checked by the Coal Controller, and after examination by him are sent to the Ministry of Heavy Industries, for making a bulk allocation after taking into account the claims of the two sectors for both maintenance of existing schemes and development needs. The detailed allocations to the two sectors are thereafter made by the Coal Controller.

With effect from April, 1957 the State collieries have been given a separate quota of cement to be operated by the Managing Director, National Coal Development Corporation (Private) Ltd. The question of allocating a separate steel quota for the State collieries is also under consideration.

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INDIAN BOILER ENGINEERS STUDY BRITISH TECHNIQUES

In the course of a study of British power and heavy-engineering techniques, three Indian engineers visiting the United Kingdom under the Colombo Plan have been spending the final stages of their tour in the Manchester region.

The engineers, who arrived in England last September, are Mr. S.K. Ghose, inspector of boilers in West Bengal; Mr. C. P. Kuruvilla, inspector of factories and boilers, Government of Kerala; and Mr. D. V. Vadera, inspector of boilers, Government of Bihar.

Hosts to the Indian engineers during their stay in Manchester have been the Vulcan Boiler and General Insurance Co., Ltd., who, as boiler, turbine, lift and crane examiners, have inspected work under construction in the United Kingdom for the Gwalior Rayon Silk Manufacturing Co., of Nagda; the electric power station at Ahmedabad; the Steel Corporation of Bengal; the Indian Iron and Steel Co.; the Assam-Bengal Cement Co.; and the Buckingham & Carnatic Mills.

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PRODUCTIVITY PROJECT RESULTS

Results of the productivity project for the engineering industries in Bombay carried out by the Productivity Centre of the Union Ministry of Labour have just been published. The Productivity Centre is one of the several interrelated divisions of the Centre Labour Institute being established in Bombay by the union Ministry of Labour. The studies, which were carried during October-December 1955, aimed at investigating the causes of low productivity in any organisation through relative comparisons and analysis of trends with a view to improving its operating efficiency. The study was an industry wise project including only engineering industries such as foundries, machining works structural fabrication machine tools manufacture and light engineering. The Government of India secured in 1952 the services of five Productivity experts from the I.L.O. with a view to initiating "Productivity Studies" in Indian Industry. Encouraged by the results, the Government set up a National Productivity Centre in 1954 with the help of a team of three I.L.O. experts. The great interest that was stimulated by the work carried out by the first I.L.O. mission in the engineering factories in Calcutta, encouraged the Centre to conduct a Productivity Project in the Engineering industries in Bombay.