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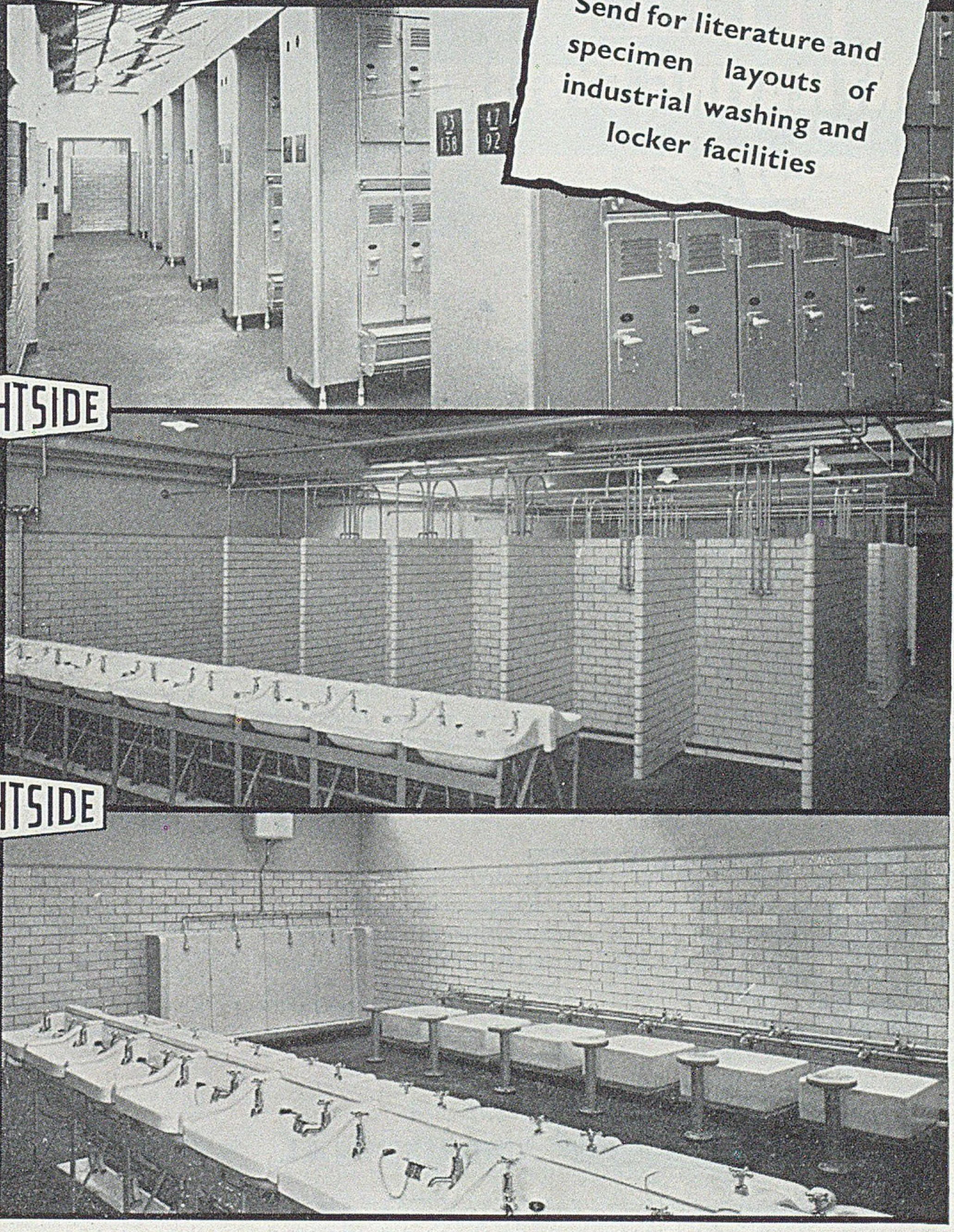

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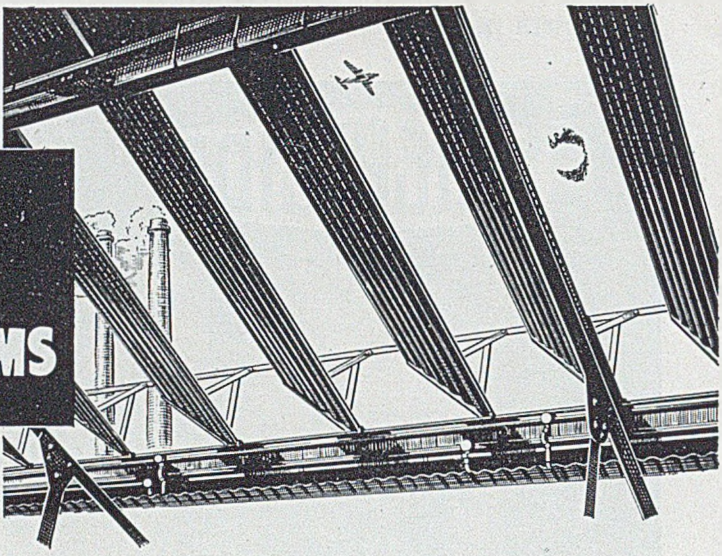

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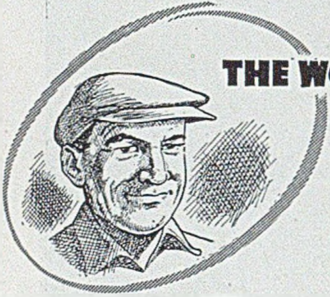

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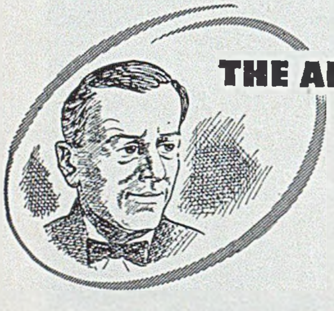

THE ARCHITECT

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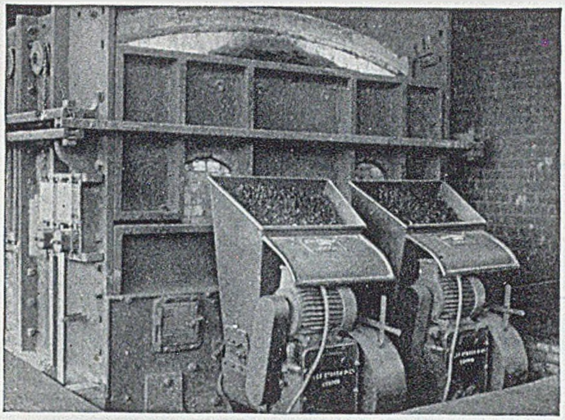

Riley Stokers firing a 40-ton air furnace.

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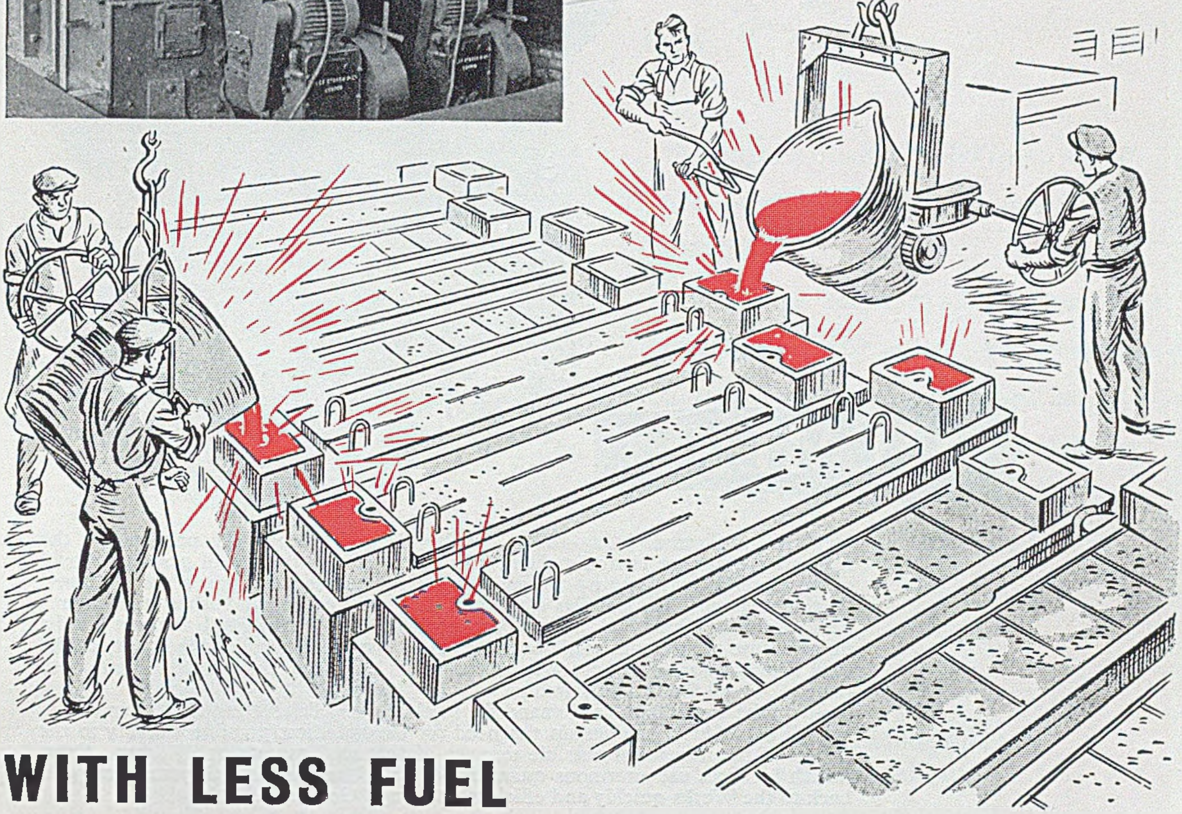

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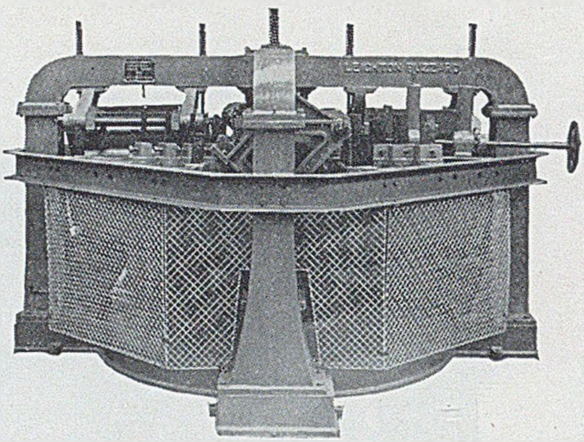

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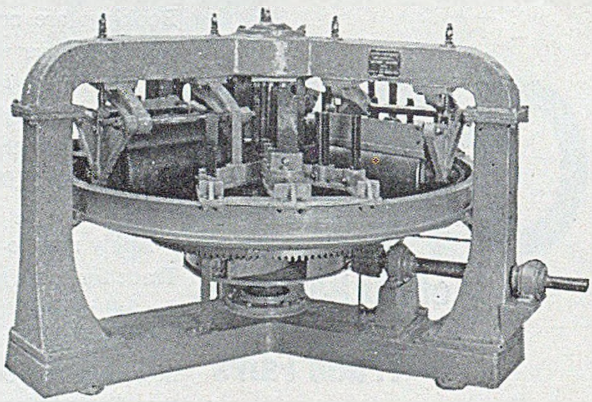

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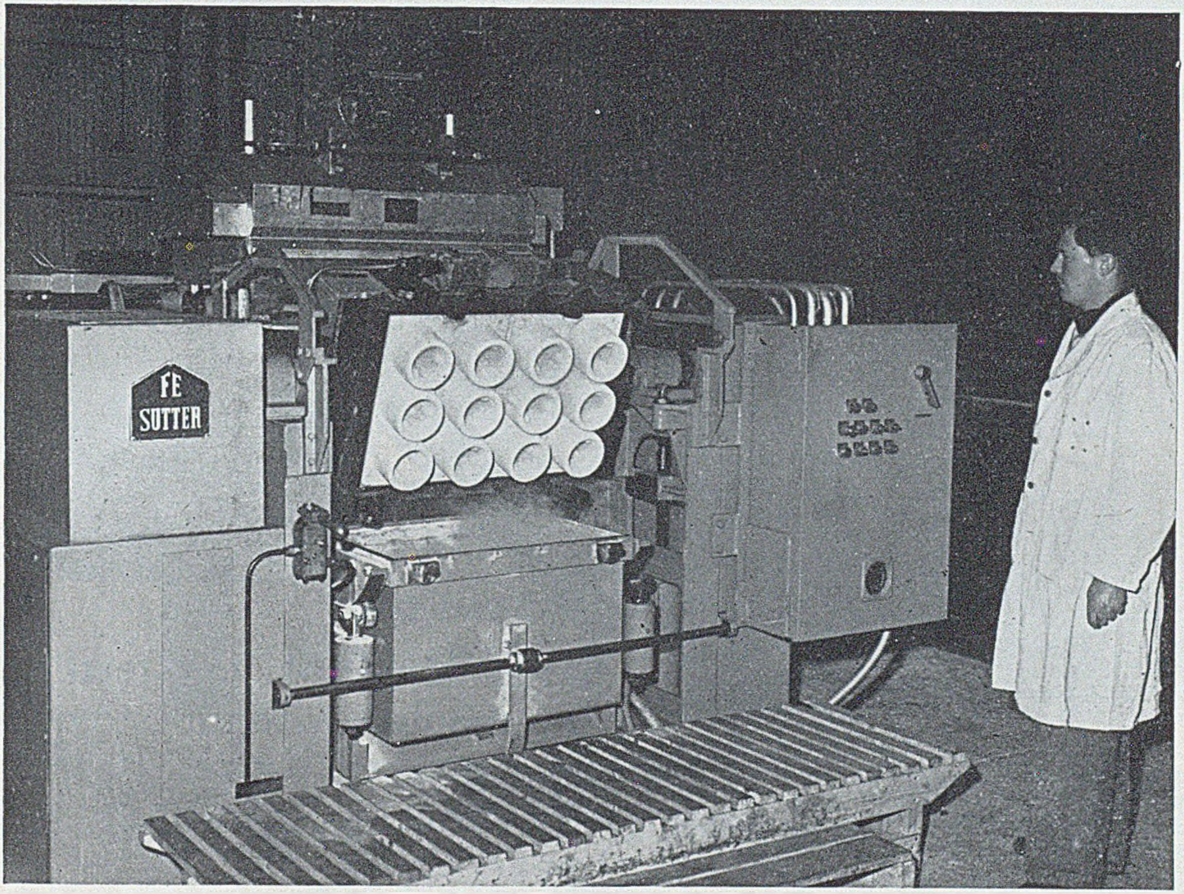

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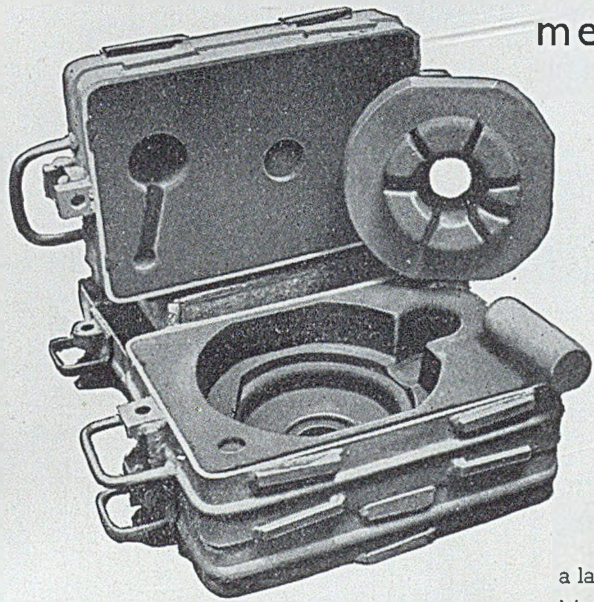

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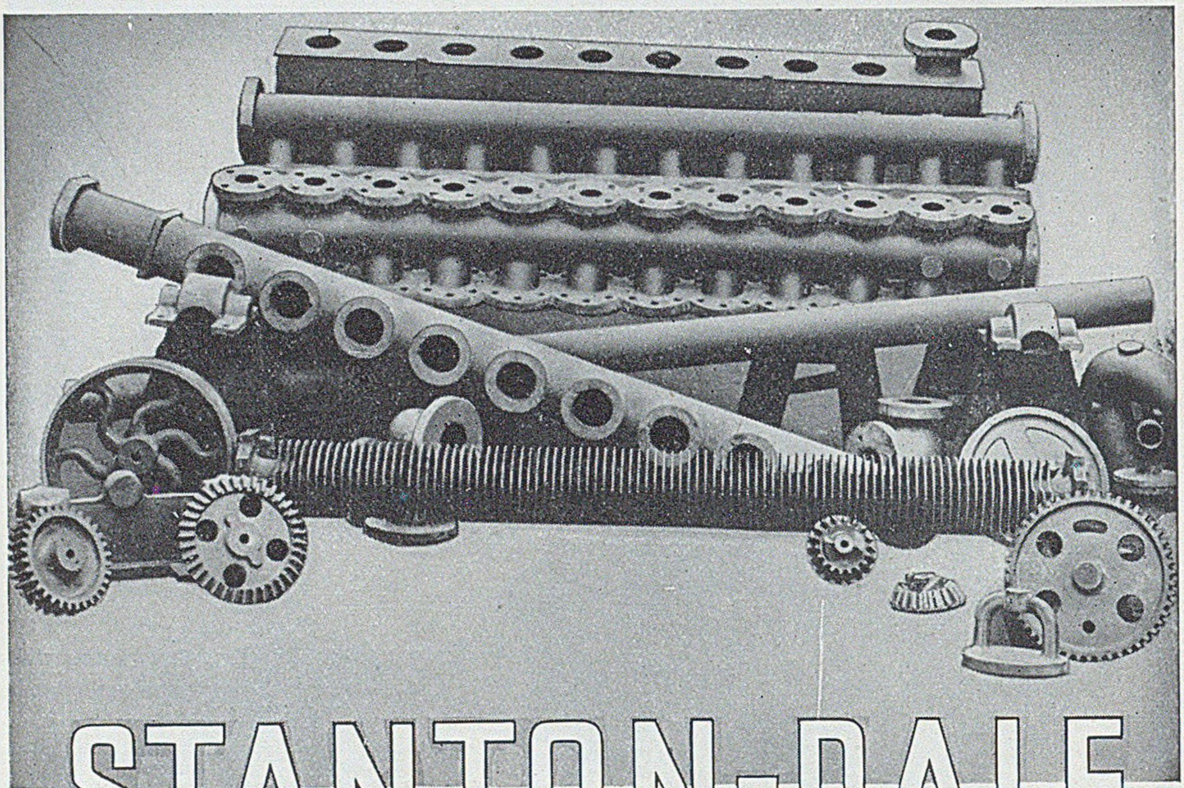

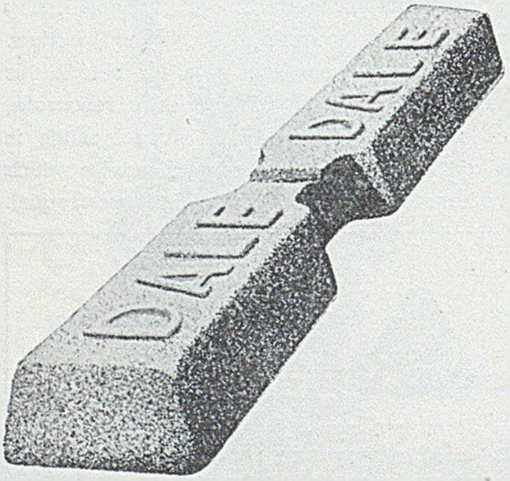
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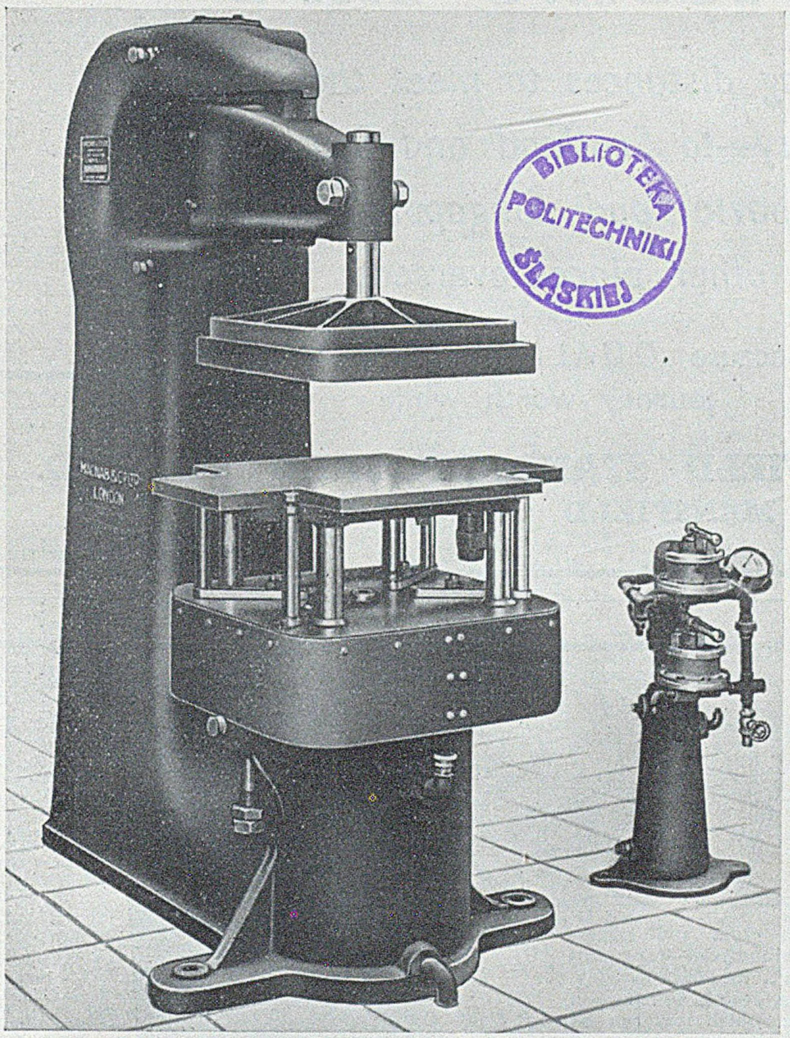

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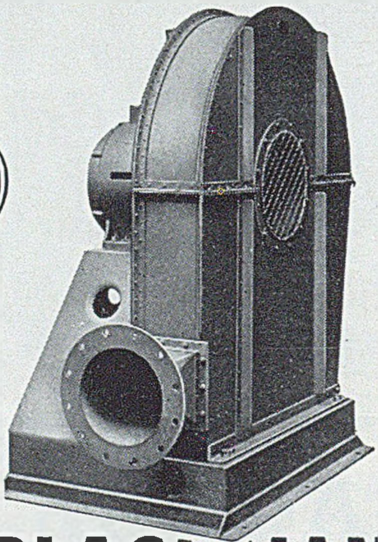

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Where the Money Goes

Everybody is now familiar with those sectioned circles, or the like, which show in a manner easily understood by even the not-so-intelligent employees, how a company's income is divided. Yet, it would appear that this is by no means the ultimate lesson that can be drawn from such efforts, and Mr. Ernest Allison, F.R.ECON.S., has taken the subject much further. His findings, based on a talk given to the Works Council of F. H. Lloyd and Company, Limited, the well-known steel founders, have been reprinted and issued as a pamphlet. In it, the author has wisely made a comparison between the works' income and expenditure with that of the average employee of the firm. Cleverly, he has made fifteen divisions for both cases and thus " materials, wages and salaries " are compared to " food "; " maintenance and depreciation of buildings " to " clothes "; " transport and carriage " to " fares "; " stores withdrawal " to " household requisites "; and " general reserve " to " contingencies." Several items, such as repairs, education, income tax and insurance are (as near as can be) parallel. When it comes to " dividends," the author has equated this item with John Smith's " recreation "—a little far fetched, perhaps, but still reasonable. His table showing the amounts is garnished with particularly apt illustrations, as for instance, against " contingencies," a feeding bottle, and a first-aid box are sketched on the household budget side. Finally, he extends his argument to the repercussions of productivity on national economy—an argument which is fundamentally sound, and yet, when expressed and illustrated so simply, is well within the comprehension of any literate person.

There is a case for further enlightenment of this kind. For instance, amongst working-class punters a 2 to 1 against " winner " is not highly regarded, yet a 25 per cent. dividend paid out by an industrial company is regarded as profiteering. One wonders if it is realized that a 2 to 1 win per day is the equivalent of some 73,000 per cent. per annum, whereas a 25 per cent. per annum dividend, if our arithmetic be correct, when expressed as odds, becomes 10,000 to 7 (tax-free, in the case of betting). Another case which is often misunderstood is that of annual income and weekly earnings. It is not uncommon to find a workman believing that a man earning £1,000 a year is a " bloated capitalist," whereas a working-class family with its members bringing in £20 a week is thought to be not too well off.

It is obvious that there is much room for intelligent instruction to be given in this field, and we regard Mr. Allison's pamphlet so highly that we suggest a copy of it should be sent to all the political parties. From the published statements of such bodies, they are all in accord with the sentiments expressed. Moreover, the Government uses a similar, simplified, presentation when issuing its annual economic survey.

D

Institution of Production Engineers

Summer School Proceedings

Speaking at the opening of the fourth annual summer school organized by the Institution of Production Engineers at Leamington, Mr. Walter Puckey, president of the Institution, said that it would be unwise for industrialists to count on getting greater freedom in the future, whatever the intentions of the present Government. He referred to the four "problem children of industry." Industry's relation with politics and industry's financial difficulties were the first two, with industry's technological tasks and its defence obligations as the third and fourth. Never, said Mr. Puckey, had industrialists taken so much interest in politics, or politicians greater interest in industry. He based his forecast of the likelihood of greater freedom on the international situation. "More competition is needed and industry must have more chances of making money and keeping it." In comparison with the depth of industry's financial difficulties, the Budget concessions were "very marginal indeed." Industry would not be able to raise its prices in the future; it would have to gain on productivity and sales and services turnover.

Challenge from German Industry

Germany's shipbuilding industry achieved a 12-fold increase from 1951 to the first five months of 1953, and German exports, which equalled 4 per cent. of British exports in 1951, have risen this year to 50 per cent. of our own. These facts were given by Sir Patrick Hannon at the summer school. From day to day, in increasing measure, the country would be faced with two main competitors, declared Sir Patrick, the United States and Germany. The prosperity of the nation's engineering industries was becoming more and more dependent on the acquisition and maintenance of overseas markets. The engineering industries were the leading factors in paying for imports. There were increases in the export of engineering goods from 1948 to 1952, but in the first five months of the year all the main groups had weakened, and over the whole field there had been a fall of 3 per cent. from the 1952 average.

Speaking of nationalization proposals, Sir Patrick said that it was now clear that the brake was being applied to the surging demands of a certain section of organized labour to bring the intervention of the State into a wide field of national production. The Trades Union Congress had lately shown a more statesmanlike tendency in dealing with the delicate problems of national economy, he averred.

The Monthly Information Sheet of the British Standards Institution for August includes:—Revised standards, B.S. 1121 : 1953, Methods for the analysis of iron and steel; determination of nickel, Pt. 2 (2s.); determination of aluminium, Pt. 4 (2s. 6d.); and copper, Pt. 5 (2s.). Specification B.S. 817 : 1938. Cast-iron surface plates and tables for inspection and marking purposes (4s.) has been reprinted.

Disturbing Criticisms of the design and effectiveness of certain items of protective clothing were made by a medical speaker at the recent safety congress held at Birmingham under the auspices of the Birmingham and District Safety Group. These criticisms were not refuted either at or after the Conference. In particular, a doctor stated that some makes of goggles intended to protect the eyes from infra-red rays allowed 25 per cent. of these rays to pass through.

Production Census for 1954

The scope of the census of production to be taken in 1955 in respect of the year 1954 and the information to be obtained have now been considered by the Census of Production Advisory Committee. It has been decided that all establishments within the field of production will be included in the census, which will be on similar lines to the full census for 1951.

The statutory form of return will include questions on:—(1) Working proprietors; (2) number of employees; (3) wages and salaries, etc.; (4) capital expenditure on plant, machinery, and vehicles; (5) capital expenditure on new building work; (6) materials and fuel purchased; (7) work given out; (8) stocks at the beginning and end of the year; (9) output; and (10) transport payments. In the wages and salaries section, firms will be asked to give information about employers' payments to superannuation and other pension funds, etc., as well as their contributions to all National Insurance schemes. This will help to complete the information available about labour costs. In the materials section, firms will be asked to state, as in the 1948 census, the total cost of materials and fuel purchased with details, by quantity and value, of the principal items purchased. Information will be sought about certain materials which are common to virtually all trades, *e.g.*, replacement parts and packing materials. In the output section, firms will be asked to show the total value of sales and work done, with details of sales of each of a number of products, on the lines of the detailed form used for 1951.

In the light of the information obtained from the censuses for 1948 and 1951, some modifications of the headings in the materials and fuel section and in the output section will be made in the forms used for certain trades. No information will be required about merchanted goods.

The trades covered by the census for 1954 will be manufacturing, mining, building and contracting, and public utilities. Any firm requiring further particulars about the census should address its inquiries to the Census of Production Office, Neville House, Page Street, London, S.W.1, stating the nature of the business carried on.

Latest Foundry Statistics

According to the August *Bulletin* of the British Iron and Steel Federation, employment in iron foundries again decreased in July. The figures taken on the fourth of that month reported that 141,120 were employed (of which 132,053 were males) as against 143,362 a month earlier and 153,665 the previous year. Steelfounding, too, employed fewer people. There was a total of 20,417 in July against 20,843 in June (19,561 a year ago). The average weekly output of steel for steel castings was down to 8,200 tons, in July as against 10,500 in June and 8,500 in July 1952.

Warning. As a result of a case where a buyer co-operating on design tried to impose a liability on the foundry for not only replacing a defective casting but reimbursing the buyer for the cost of its machining, the Council of the Association of Bronze and Brass Founders affirmed that in no circumstances should founders accept liability for the machining of castings which prove defective.

R. Hyde & Son, Limited, plan to extend the foundry and erect a new retaining wall in Clayton Street, Chesterfield.

Inter-relation of Combustion and Metallurgical Reactions in the Cupola*

By D. Fleming

In spite of the vast amount of literature dealing with the cupola, the Author feels that a restatement of some of the fundamentals of cupola behaviour, indicating possible relationships between the combustion conditions and some of the more important metallurgical reactions, is desirable at this time in view of a trend away from the conventional cold-blast, acid-lined cupola for the quantity melting of soft grey iron. The cupola behaviour diagram of Jungbluth and Korschan is first cited as a starting point, based on experimental data. This is examined and shown to relate $CO:CO_2$ ratios to $C:Fe$ ratio independently of blast volume (the errors of classical methods of blast-volume computation are thus exposed). The effects of $C:Fe$ ratio, coke size, and blast temperature are considered and the mechanism of combustion indicated. The concept of a reaction temperature is introduced, together with synthetic and experimental curves; the deduced zone behaviour is compared with the results of Vogel.

Reactions possible in the shaft of the furnace are then considered, followed by similar considerations for the melting zone and hearth, the fundamental importance of high temperature and low iron-oxide production is pointed out, together with the importance of the control of slag/metal reactions. An ideal is suggested for soft grey iron melting and it is claimed that the necessary control can be obtained, using a combination of hot-blast, water-cooling, and continuous tapping. It is claimed that such a cupola would allow soft grey iron to be economically produced without the need for pig-iron, should supplies of ferro-alloys, and iron and/or steel scrap be available.

The cupola has been the traditional melting unit of the iron founder practically as long as iron foundries, as such, have existed, and during this time much thought has been given to the principles underlying cupola operation, and many thousands of words have been written on the subject and many thousands more spoken in discussions between interested foundrymen the world over. In spite of this, the Author, believing that the cupola, which has undergone so many variations of a transient nature in the past, is now emerging into a period of development of greater significance than ever before, feels that a restatement of some of the fundamentals of cupola behaviour and a presentation of some of the remaining problems is justified at this time, if only to provoke a greater number of the members of the Institute of British Foundrymen into applying themselves to such development, and to recovering the lead in cupola "know-how" which has passed into the care of continental workers.

In any study of the cupola, it is first necessary to consider the laws which govern the combustion conditions occurring, as without an appreciation of these, no sound approach to metallurgical considerations can be made. Any theories developed, however, must rest on experimental data if they are to carry conviction. It is proposed first to consider the work of Jungbluth and Korschan.[1] These two authorities used an experimental cupola lined to a diameter of approximately 21½ in., with a stack height from tuyeres to charging point of some 12½ ft. The blowing equipment was arranged so that any air volume between 353 and 1,235 cub. ft. per min. could be supplied under controlled conditions, and accurately measured, the danger of error through leakage being eliminated by welding of the blast main and the cupola. The charges were of pig-iron (TC 4.16, Si 2.21, and Mn 0.69 per cent.) in pieces approximately 9 by 4.7 by 4.7 in., 660 lb. being used per charge. Coke of 4 to 5 in. section and 7 to 8 in. length was used, 440 lb. being used for the bed. The coke had a fixed carbon of 88.65, sulphur 1.07, moisture 2.2, and ash, 6.39 per cent. Limestone of 98.7 per cent. $CaCO_3$ content was used to the extent of 3 per cent. of the metal charge. Iron, coke and limestone were carefully charged in layers, and, in a series of experiments each lasting for some 6 to 8 hrs., the relationship of melting rate, metal temperature, blast volume, and coke percentage, was established for coke percentages of 6, 7, 8, 9, 10, 11, 12, 13 and 14 per cent. for each of the four blast-volume rates of 15, 20, 25 and 30 cub. m. per min. (530 to 1,060 cub. ft per min.).

American investigators[2] have since subjected the original graphical presentation of Jungbluth and Korschan to a progressive method of interpolation and have then checked it over a period of a year's working with a 72-in. cupola over the iron:carbon ratio variation from 6.75 to 8.5. Fig. 1 shows such an American chart for a 36-in. cupola. To use this chart for any other size of cupola of diameter, D in., the air volumes and melting rates should be multiplied by the factor $\left(\frac{D^2}{36^2}\right)$ and the temperature, which incidentally is the "corrected" temperature, should be found from $T_2 = (T_{chart} - 36 + D)$ deg. F. It should also be noted that, to minimize difficulties due to varying coke-ash contents, etc., iron:carbon ratios are used and not iron:coke

* Paper presented to the Institute of British Foundrymen at their fiftieth annual meeting. The Author is metallurgist and foundry technician, Textile Machinery Makers Limited.

ratios, also the air volumes given are for air at 32 deg. F. and at a pressure of 29.92 in. of mercury. Check observations should not be made on any cupola until it has been in steady operation for an hour, so that the bed height has become steady and the actual coke ratio and the charged coke ratio identical.

This chart (Fig. 1) shows that, with a given type of coke, an increase of coke percentage at constant blast volume gives increased metal temperature and a decrease of melting rate, whereas with a constant coke percentage, an increase of blast (within the range of the chart) leads to an increase of metal temperature and an increase in melting rate, facts which, in a general way, are known to most cupola operators. The great value of the work of Jungbluth and Korschan, presented in this "Cupola Behaviour Diagram," however, is that it shows the inter-relationship of these variables in a quantitative manner and thus allows other factors, not immediately apparent, to be calculated.

Consideration of Fig. 1 shows that, with the coke type and size on which the diagram was based, at a melting speed of 10,000 lb. per hr. and an iron : carbon ratio of 9 : 1, the air supply will be 2,000 cub. ft. per min. of air at 32 deg. F. and 29.92 in. of mercury. Now, as the diagram is concerned with equilibrium states of melting, if the melting rate is 10,000 lb. per hr. and the iron : carbon ratio is 9 : 1, $\frac{10,000}{9}$ lb. per hr. of carbon must be consumed, *i.e.*, 1,111.1 lb. per hr.

From the equation $C + O_2 \rightarrow CO_2$, however, it is known that one pound . molecule of oxygen reacts with one pound . molecule of carbon to produce one pound . molecule of CO_2. Now one pound . molecule of oxygen at S.T.P. (32 deg. F., 29.92 in. Hg), allowing for the deviation from the ideal gas law, occupies 358.6 cub. ft. and, as the deviation for air also gives a volume of 358.6, and the oxygen content of the air is 20.92 per cent., it can be said that:—

12 lb. of carbon react with $\frac{358.6}{0.2092}$ cub. ft of air at S.T.P.; or 1 lb. of carbon burnt to CO_2 requires $\frac{358.6}{12 \times 0.2092} = 142.85$ cub. ft. of air at S.T.P.

In the example quoted, the air rate at S.T.P. = 2,000 cub. ft. per min., or 120,000 cub. ft. per hr., and the amount of carbon that this air will burn to $CO_2 = \frac{120,000}{142,85}$ lb. = 840.04, therefore, as 1,111.1 lb. of carbon are consumed, 1,111.1 − 840.04 = 271.07 lb. must be used in the reduction

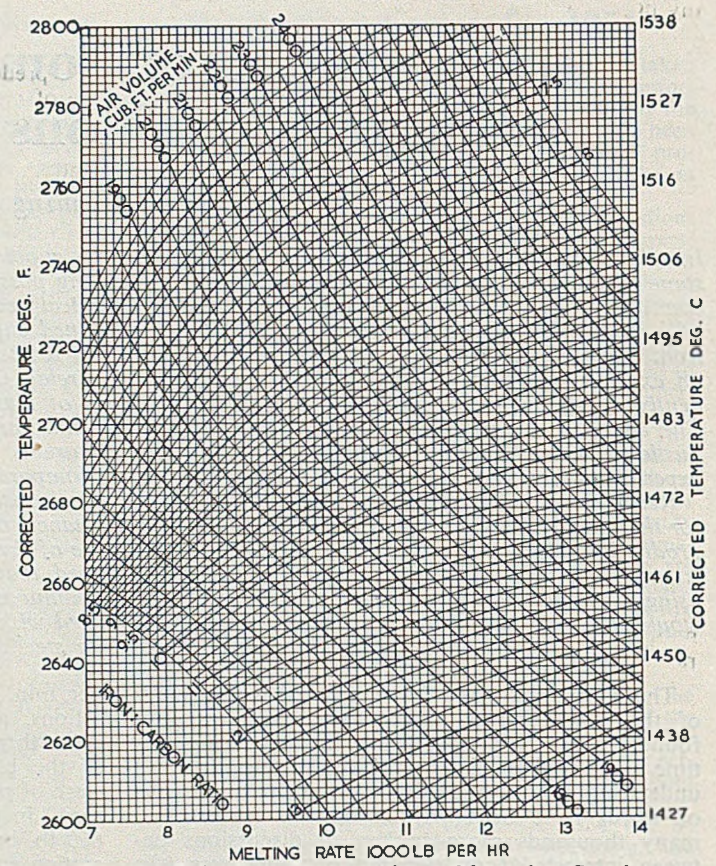


FIG. 1.—*Behaviour Diagram for a 36-in. dia. Cupola, with Air at 32 deg. F. and Atmospheric Pressure at 29.92 in. Mercury. (From Jungbluth & Korschan.)*

to carbon monoxide according to the equation $CO_2 + C \rightarrow 2CO$. The final weight of carbon burnt to CO_2, at the conclusion of all reactions, will thus be:—

$$840.04 - 271.07 = 568.97 \text{ lb. per hr.}$$

and the final weight of carbon burnt to CO will be:—

$$2 \times 271.07 = 542.14 \text{ lb. per hr.}$$

If one now treats CO and CO_2 as if they were ideal gases* it can be seen from the equations:—

(i) $C + O_2 \rightarrow CO_2$
(ii) $2C + O_2 \rightarrow 2CO$

that equal weights of carbon burnt to either state of oxidation give equal volumes, so that it can now be said, in the example given, that the CO : CO_2 ratio in the effluent gases arising from the combustion of carbon when the iron : carbon ratio is 9 : 1 and the melting speed is 10,000 lb. per hr. is $\frac{542.14}{568.97} = 0.953$. In the same manner as this example, the CO : CO_2 ratio can be worked out for

* The error introduced by this assumption gives an answer about 0.6 per cent. lower than that obtained if the deviations of CO and CO_2 from the ideal gas laws at S.T.P. are taken into account.

any point on the diagram of Fig. 1. This has been done for a number of points in the region lying above the iron:carbon ratio of 9:1, and the results are given in the form of a set of curves in Fig. 2.

These curves show immediately that the $CO:CO_2$ ratio resulting from carbon combustion is controlled almost exclusively by the iron:carbon ratio of the charge, *i.e.*, in practical terms by the coke ratio, and that changes in air volume have but a minor effect on the effluent gas analysis.

This factor incidentally shows the complete fallacy of all air calculation methods which are based on the lines of the following example:—

(1) Melting rate .... — S lb. per hr.

(2) Ratio $\frac{\text{iron in charge}}{\text{carbon in coke}}$ .... = R

(3) Carbon burnt per hr. .... = $\frac{S}{R}$

(4) Cub. ft. of air per lb. of carbon for desired stage of combustion .... = v

$\therefore$ Air required (V) = $\frac{S \times v}{60R}$ cub. ft. per min.

Such methods are completely erroneous because they assume that one can simultaneously predetermine the three factors melting rate, iron:carbon ratio, and stage of combustion, in any desired relationship, and then calculate the fourth member, *i.e.*, the air volume required. In fact, as is shown by Figs. 1 and 2, the laws of cupola operation reveal that, with a given melting rate and coke ratio, there is, for a given type of coke, only one possible air volume and one possible stage of combustion.

Applications

Having established the general concept that, with a given constant type of fuel, and air at a standard pressure and temperature, the $CO:CO_2$ ratio at the completion of the reactions concerned with the burning of the coke carbon will be controlled by the iron carbon ratio. Let us consider, therefore, the general mechanism of combustion in the cupola: It is postulated that, of the two possible reactions

(1) $C + O_2 \rightarrow CO_2$
(2) $2C + O_2 \rightarrow 2CO$

the result up to the point where free oxygen has been consumed is such that equation (1) is the only one which need be seriously entertained, as, even if at the immediate coke surface equation (2) is operative, it is instantly followed in the gas phase by the reaction $2CO + O_2 \rightarrow 2CO_2$. The zone of oxygen disappearance, where the overall reaction $C + O_2 \rightarrow CO_2$ is predominant, is referred to as the oxidation zone.

Now the combustion behaviour of the carbon of the coke in a cupola is not determined by purely chemical considerations, but by a combination of chemical and physical factors, as, before any reaction can occur between the carbon and the oxygen, the two reactants must be brought into intimate contact. Further, the speed of the chemical reactions increases with temperature, becoming extremely rapid at high temperatures, whereas at low temperatures the rates are low. Thus at low temperatures it is found that chemical reaction rates predominate, whereas at high temperatures the rate of reaction between the solid coke surface and the oxygen of the gas phase depends almost entirely on physical factors, and becomes less dependent on temperature.

The most important physical characteristic is the size of the fuel, and hence the surface area per unit volume presented to the gas phase. From this, it also follows that high-temperature reaction rates will not only increase with diminishing particle size, but will also be, in some degree, affected by the cellular structure of the fuel surface, and the degree of interference exhibited by the ash network remaining as carbon disappearance proceeds.

The rate of air admission will also affect the rates of reaction in two ways:—

(1) The cooling effect of the air will be greater per unit volume with higher air speeds, and greater cooling in the medium-temperature zone will then slow down the chemical reaction rate.

(2) In the upper-temperature range, where physical factors predominate, the increased speed will also result in more violent turbulence so that the apparent reduction of contact time will be counterbalanced by a more vigorous reaction, due to an increased number of actual contacts between the reacting atoms.

At the upper limit of the oxidation zone it may reasonably be expected that, with only a small amount of oxygen remaining in the gaseous phase,

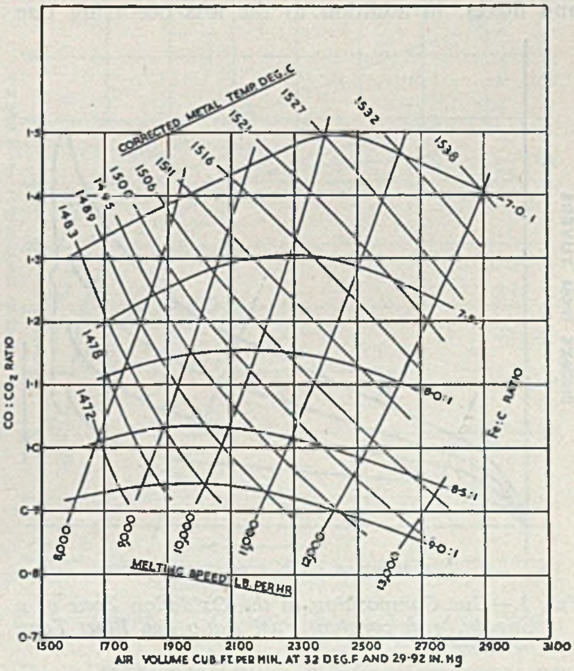


FIG. 2.—*$CO:CO_2$ Ratios extended from the Values given in Fig. 1 for Iron: Carbon Ratios above 9:1 for the 36-in. dia. Cupola.*

Reactions in the Cupola

the reaction $C+O_2 \rightarrow CO_2$ will again slow down due to the decreasing number of probable contacts between the two reactants. With the above factors in mind, a picture of the course of the reaction can be assembled, as in Fig. 3.

Turning next to the reduction zone, in which the reaction $CO_2+C \rightarrow 2CO$ predominates, similar considerations apply. The reaction in this zone starts at high temperature however, and initially the rate of reaction will be dependent mainly on the physical factor of the fuel size, after a short range in which the reaction coincides with the finish of the oxidation zone in areas temporarily starved of oxygen but rich in C and CO_2. The reaction $CO_2+C \rightarrow 2CO$ is endothermic, however, and its course is therefore accompanied by a cooling of the gas phase and the fuel surface, which proceeds until the temperatures are such that the rate of the chemical predominates over the physical factors of fuel size, but being dominated by a fresh circumstance.

To appreciate this, the heat sources at the upper part of the reduction zone must be examined. Here, the fuel is descending in the furnace at a rate controlled by the melting rate, which is in turn controlled by the iron:coke ratio and the air speed, and the descending fuel is being heated, first by the rising hot gases, and, in the reaction-zone proper, by radiation and conduction from the material in the high temperature oxidation zone also. The hot gases from the oxidation zone, however, are being rapidly cooled in the reduction zone by losing heat to the metal charge, the descending coke, and fluxes, in addition to the loss occurring due

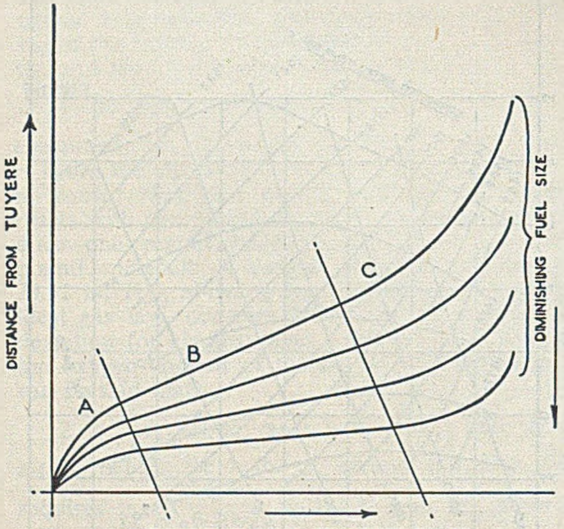


Fig. 3.—*Gas Composition in the Oxidation Zone of a Cupola, with constant Fuel Ratio and Blast Temperature.*

Zone (A): increasing gas temperature, chemical rate predominant, but modified by rate of air temperature gain; *Zone (B)*: rate controlled by fuel size and turbulence, and only partly by temperature and *Zone (C)*: conditions as in (B) but rate reduced by oxygen starvation.

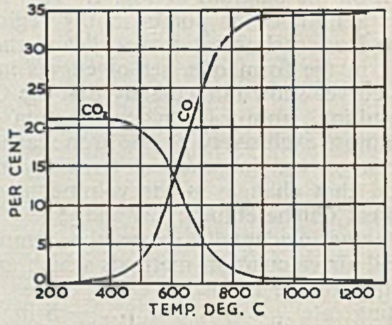


Fig. 4.—*Boudouard Reaction Equilibrium Curves, i.e., the CO/CO_2 Relationship produced from Air in contact with Carbon at Different Temperatures.*

to the endothermic reaction $CO_2+C \rightarrow 2CO$. The descending coke therefore reaches a point where its rate of temperature rise is sharply increased as it enters the reaction zone. Simultaneously, the rising gases are rapidly falling in temperature at this level, and they continue to do so until the point is reached where the temperature differential between gas and fuel surface is insufficient to ensure a rapid enough heat transfer to offset the heat loss of the endothermic reaction; at this point the endothermic reaction ceases.

The temperature at this point, known in gas-producer practice as the "reaction temperature," is most important, as the gas composition existing at the time the endothermic reaction $CO_2+C \rightarrow 2CO$ ceases will be virtually that of the exit gases, as no further reactions normally occur in the cupola to alter this ratio, and this gas composition will be that composition in equilibrium with the coke carbon at the reaction temperature. The relationship of CO to CO_2 produced from air in contact with carbon at different temperatures is shown in the equilibrium curves for the Boudouard reaction in Fig. 4, from which it will be seen that the ratio $CO:CO_2$ rises with temperature.

Conditions Governing the Reaction Temperature

With a given type of fuel, it will be seen that, if, at a constant fuel burning rate, the heat balance at the plane in furnace which is at the reaction temperature T is considered, the total heat-balance can be drawn up for this plane, if one makes one assumption, *i.e.*, that the fuel, burden, and gas phase are all at temperature T_R in this plane. The heat balance is then that for the whole of the reactions occurring in the furnace reaction zones up to (in the physical sense) the temperature level T_R in the reduction zone. (See Fig. 5.)

The heat supplied to this zone then consists of:—

(i) The total heating value of the fuel—FH_i

(ii) The enthalpy of the fuel at temperature .. .. .. T_R-FH_c

(iii) The enthalpy of the burden at temperature .. .. .. T_R-$F\mu H\mu$

(iv) The enthalpy of the blast .. MH_M

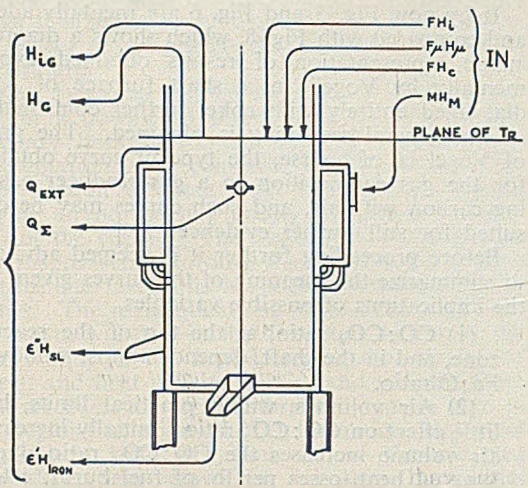


FIG. 5.—*Cupola Heat Balance at Location of Reaction Temperature* T_R.

The heat leaving this zone consists of:—

(i) H_i, G .. The heating value of the product gas (composition in equilibrium at T_R).

(ii) H_G .. The enthalpy of the product gas at temperature T_R.

(iii) $F\mu Q_\Sigma$ .. The heat required for reactions (such as slag formation, metal oxidation, etc.).

(iv) $F\mu\epsilon' H_{iron}$ .. The heat content of the tapped iron, including heat of fusion, at its tapping temperature.

(v) $F\mu\epsilon'' H_{sl}$ .. The heat content of the tapped slag, including heat of fusion, at its tapping temperature.

(vi) Q_{EXT} .. The heat lost externally by radiation, conduction (and in the cooling water, if any).

Where F is the fuel quantity chosen, and μ is the ratio of burden to fuel.*

ϵ' is the yield of tapped iron from the burden.

ϵ'' is the yield of slag from the burden.

Thus $FH_i + FH_c + F_\mu H_\mu + MH_M = H_{i,G} + H_G + F_\mu (Q_\Sigma + \epsilon' H_{iron} + \epsilon'' H_{sl}) + Q_{EXT}$

therefore

$$FH_i + FH_c + F_\mu [H_\mu - Q\Sigma - \epsilon' H_{iron} - \epsilon'' H_{sl}] + MH_M - Q_{EXT} = H_{i,G} + H_G.$$

Now, if a given fuel ratio be chosen, the heat content of each side of this equation can be plotted against a series of different values of T_R, and the point of intersection will give the value of T_R, and, if the process be repeated for a number of fuel ratios, a graph of T_R against fuel ratio will be obtained, and hence of $CO:CO_2$ ratio against fuel ratio.

Such a graph is shown in Fig. 6, from data calculated by Gumz[3], also shown on the same graph are curves by the same authority, prepared in the same manner, for cupolas operating with blast temperatures of 300 and 600 deg. C., and the measured data of Jungbluth and Heller[4], which links up with the data of Jungbluth and Korschan referred to in Figs. 1 and 2. Data are also included, produced by Bader working with a hot-blast cupola with a blast temperature of 600 deg. C., and one point is included by the Author, from data, given by De Bock, for a hot-blast cupola operating with a carbon: iron percentage of about 18 per cent., and a blast temperature of 500 deg. C.

It is claimed that the degree of agreement of these data is sufficient to confirm the general mechanism of combustion put forward, and to verify the general factor, shown by Fig. 2, that the $CO:CO_2$ ratios achieved in cupola practice are almost wholly controlled, with a constant type of fuel, and constant blast temperature, by the fuel ratio, and only to a minor degree by air volume, within the practical limits of cupola operation.

The Author claims, however, that precise data cannot be obtained for all cases by the heat-balance method of Gumz, albeit, an approximation will be obtained as shown by Fig. 6. The reason for this lies in the assumption, made in this calculation, that at the plane of T_R, the fuel surface temperature and the gas temperature are identical, whereas it was stated earlier that there would still be a temperature differential in favour of higher gas temperature to supply the heat for the endothermic reaction $CO_2+C \rightarrow 2CO$. Further, the coke surface

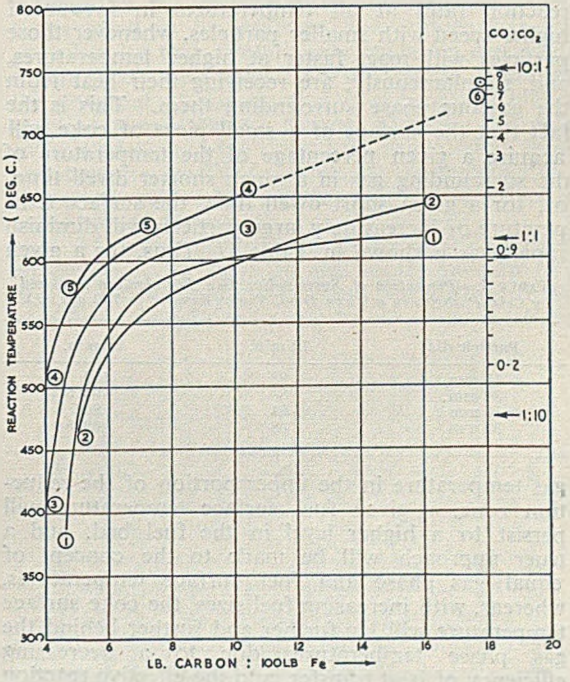


FIG. 6.—*Graph of* T_R *(and, hence,* $CO:CO_2$ *Ratio) against Fuel Ratio.*

(1)—(1) Calculated cold blast (Gumz); (2)—(2) actual cold blast (Jungbluth & Heller); (3)—(3) calculated T_M=300 deg. C. (Gumz); (4)—(4) calculated T_M=600 deg. C. (Gumz); (5)—(5) actual T_M=600 deg. C. (Bader) and (6) actual T_M=500 deg. C. (De Bock).

* Only the carbon of the fuel is considered, volatile matter being lost prior to T_R and the ash being considered part of the burden.

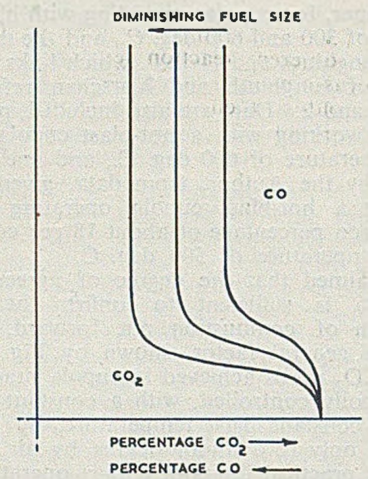


FIG. 7.—*Gas Composition in Reduction Zone and Stack of a Cupola, according to Fuel Size.*

temperature must be T_R, even if the whole of the heat of reaction is supplied from the gas phase which is at a temperature sufficiently higher. Now, coke has already been said to have faster reaction rates at high temperatures for pieces of small size, than for pieces of large size, in the higher temperature region—due to surface-area effects. A second factor may now be mentiond which affects reaction rates at all temperatures in favour of higher speed with smaller particles, whenever those particles will react faster at higher temperatures, and, simultaneously, are receiving their heat from the gaseous phase surrounding them. This is the fact that the surface of a small piece of coke will acquire a given percentage of the temperature of the surrounding gas in a much shorter dwell time, or, for a given short dwell time, the surface temperature of increasingly large particles will diminish rapidly as is shown in Table I. Thus, for a given

TABLE I.—*Percentage of Surrounding Gas Temperature Acquired by Coke Particles in a Given Dwell Time (Range 0 to 700 deg. C.).*

Particle dia.	12 min.	24 min.
15 mm.	98	100
30 mm.	88	97.5
50 mm	64	86
70 mm.	38	69.5

gas temperature in the upper portion of the reduction zone, a given fuel surface temperature will persist to a higher level in the fuel bed, and a truer approach will be made to the concept of equal gas phase and fuel surface temperatures, whereas, with increasing fuel sizes, the coke surface temperature will lag further and further behind the gas phase temperature, due to a decreasing efficiency of heat transfer, and the effective reaction temperature will be increasingly lower. This effect is shown in diagrammatic form in the curves of Fig. 7 which deals with the reduction zone and the stack-gas composition, on the basis of the deductions made, in the same way that Fig. 3 deals with the oxidation zone.

If by now Fig. 3 and Fig. 6 are mentally added, and compared with Fig. 8, which shows a diagrammatic representation of results obtained experimentally by Vogel[5] in a shaft furnace of 4 in. dia. filled entirely with coke, further confirmation of the general reasoning is obtained. The graph of Vogel is, of course, the type of curve obtained for the gas composition in a gas-producer gasifying carbon with air, and such curves may be consulted for still further evidence.

Before proceeding further it is deemed advisable to summarize the meaning of the curves given, and the implications of possible variables.

(1) $CO:CO_2$ ratio, at the top of the reaction zone, and in the shaft, depends almost wholly on Fe:C ratio.

(2) Air volumes, within practical limits, have little effect on $CO:CO_2$ ratio. Initially increasing air volume increases the $CO:CO_2$ ratio due to lowered heat losses per lb. of fuel burnt; after a maximum, however, further air then lowers the $CO:CO_2$ ratio, presumably because the reduction zone is then accepting fresh carbon at a rate too high for efficient heat transfer.*

(3) Within the limits of the curves shown, increasing air gives increasing temperature and melting speed at a given coke ratio (lower heat losses).

(4) Increasing coke ratio, at constant air volume, gives higher $CO:CO_2$ ratio, hotter metal and slower melting rate.

(5) Smaller coke gives higher $CO:CO_2$ ratio, but colder metal, and faster melting rate.

(6) Increased blast temperature, at constant coke ratio, gives higher $CO:CO_2$ ratio, hotter metal, and faster melting rate.

(7) The cupola behaves as if the combustion reactions were (i) $C+O_2 \rightarrow CO_2$ continuing until oxygen is virtually absent, and (ii) $CO_2+C \rightarrow 2CO$. The maximum flame temperatures for zone (1) (the oxidizing zone) are therefore almost the theoretical values for $CO:CO_2$ approaching zero, say, about 2,000 deg. C. for cold blast, or some 2,400 deg. C. for a blast temperature of 600 deg. C.

(8) Reduced fuel size, or hot blast, shorten the zones, and thus decrease the area in which free oxygen exists, though the first method reduces efficiency much more than the latter, and is less effective. (Incidentally, increased oxygen content in the blast would also have a similar effect.)

(9) At a temperature of 1,100 deg. C., in the absence of fresh supplies of oxygen or carbon dioxide, the $CO:CO_2$ ratio of a gas derived from air and carbon is over $10^3:1$, and rises rapidly with increasing temperature. (Fig. 4.)

With this information in mind, Fig. 9(*a*) is presented merely as a diagrammatic aid to further consideration of the internal conditions obtaining in a cupola. Areas (1) and (2) indicate, respectively, the zones cooled by the incoming blast, and the

* The Author believes that if air volume were increased sufficiently, the oxidation zone would also be overloaded by cold air and metal, and metal temperatures would also decline, *i.e.*, the temperature curves of Fig. 1 represent one side only of a parabolic curve.

limiting boundaries of free oxygen; it has been shown that the point of disappearance of free oxygen is also approximately the point of peak flame temperature.

In an operating cupola, however, there is no gas flow in a downward direction so that whilst the boundary lines shown are believed to be a fair representation, the combustion occurring in the lower portion of these areas will be that due to eddying air not passing deeply into the lower portions of the cupola. The main flow of gas will be upwards, resistance towards the centre being at some intermediate level, this is roughly indicated by the arrows. The main quantities of heat carried by the gas stream will flow in the directions shown by the arrows and, as the heat losses at the centre are lowest, and heat is being carried and radiated there from all sides, the temperature will remain high in this region, in spite of CO formation, the peak temperature zone will thus follow the accepted saucer-like shape shown by the upper boundaries of the areas (2), and the heavy broken line.

In an upward direction from this boundary, heat will be used to melt and heat the metal and to melt and heat slag components and the fuel, in a stream of gas of fairly uniform flow, with CO_2 diminishing and CO rising, until the end of the reduction zone when the gas temperature will be at least T_R, and the fuel temperature will be T_R, and the gas composition that shown by the previous figures.

Heat will be carried downwards, however, by radiation and by conduction, the temperature being maintained at a high level by the molten iron and slag constantly washing downwards, and thus the higher the temperature generated in the upper zone the higher will be the "well" temperature. The gas composition in this area will thus consist almost entirely of CO, and the conversion of CO_2 to CO will use but little heat as gas flow does not occur to any significant degree. It can, in fact, be expected that the $CO:CO_2$ ratio in this area will closely approach the equilibrium value for the temperature reached. The centre zone between the free-oxygen lobes will also tend to high CO values, but as a constant flow of CO_2 will enter the zone, the $CO:CO_2$ ratio will be at an intermediate value. Figs. 9(*b*), 9(*c*) and 9(*d*) have been prepared to show these effects, and refer respectively to conditions in the planes A-B-C, E-F-G, and E-H, in Fig. 9 (*a*).

Cupola Sectional Reactions

Consideration can now be given to the reactions possible in the main sections of the cupola.

I *The shaft* (*i.e.*, the cupola from charging door down to the level of T_R, in which the temperature of the charge is raised from normal to a level of about T_R, and the $CO:CO_2$ ratio of the gases is constant at a figure dependent on T_R), is first considered. In the upper region, water will be evaporated and other matter volatilized at low temperature will be removed. To determine whether the tendency will then be towards reduction of oxides or a creation of further oxides, the position with respect to iron and its oxides is first examined. Fig. 10 shows the Boudouard-reaction curve ($CO_2 + C \rightleftharpoons 2CO$ plotted against reaction temperature) and, superimposed on it, the equilibrium curves for the reactions between the iron oxides and CO/CO_2 mixtures at different reaction temperatures.

Let two cases now be taken:—

(*a*) A cold-blast cupola is run with an iron: carbon ratio of 12.5:1 (12:1, coke:iron with 4 per cent. ash coke), *i.e.*, 8 lb. coke carbon per 100 lb. iron, then the reaction temperature, using curve 2, Fig. 6, will be approximately 575 deg. C. Thus, for all temperatures below 575 deg. C. in the shaft, the CO per cent. will be of the order of 8.2 per cent., and it can be seen from Fig. 10 that, at all temperatures below 575 deg. C. (in fact at all temperatures below about 840 deg. C.) this gas is oxidizing and would tend towards the production of Fe_3O_4.

(*b*) Let a cold-blast cupola be run with a 15½ lb. coke carbon per 100 lb. iron ratio, then, from curve (2), Fig. 6, the reaction temperature will be 640 deg. C., and it will be seen from Fig. 10 that, at all temperatures below this, the tendency would be to reduce all oxides of iron to the metal.

It is also clear that the higher the reaction temperature is raised by percentage fuel increases, hot blast, or both, the greater is the movement towards reducing conditions with respect to iron oxides in the shaft. Fig. 11 shows the position with respect to manganese, and it will be seen from this that, in this case, even if very high reaction temperatures are achieved, any reduction beyond the oxide MnO achieved in the cooler portions of the stack would be reversed as the reaction temperature was approached, so that, overall, only oxidation can occur in the shaft with respect to manganese, although the potential of the reaction is reduced by higher reaction temperatures. Silicon, likewise, can only suffer oxidation in the stack with any possible reaction temperature T_R, as, similarly, the highest $CO:CO_2$ ratio achievable will be too low to effect a reduction of SiO_2 to Si.

II. *The zone* between the plane of the reaction temperature, T_R (end of the shaft) and the top of the "well" is a much more complicated zone, as different conditions occur at the outer portions

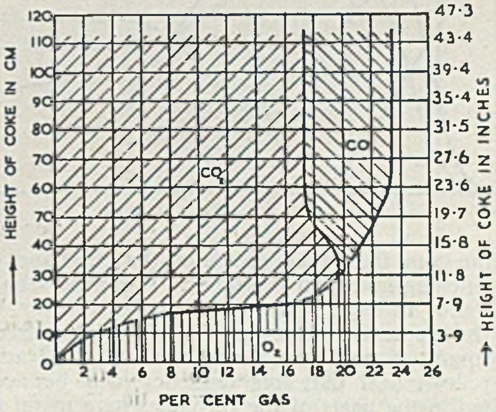


FIG. 8.—*Combustion Conditions in an Experimental Cupola 4 in. dia.* (*after R. Vogel*).

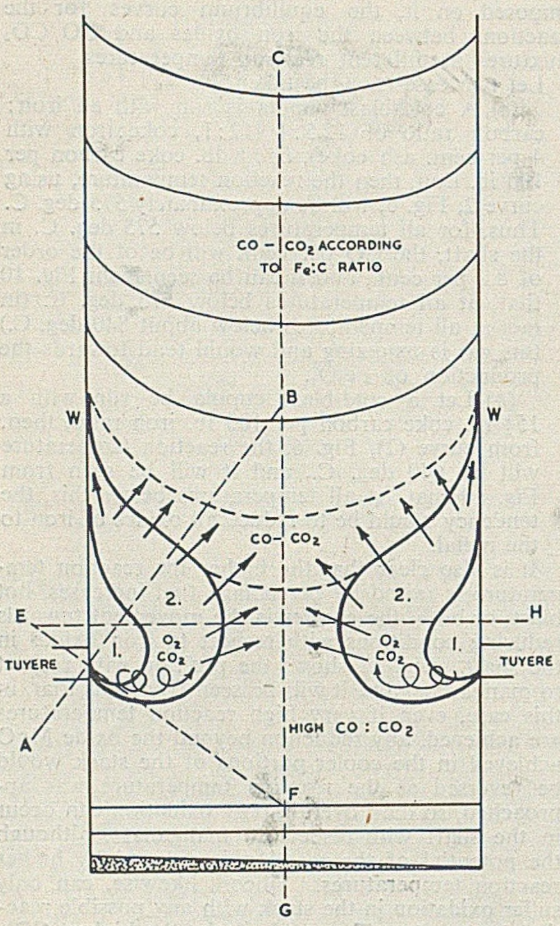


FIG. 9 (*a*).—*Diagrammatic Representation of Conditions obtaining in a Cupola Cross Section.*

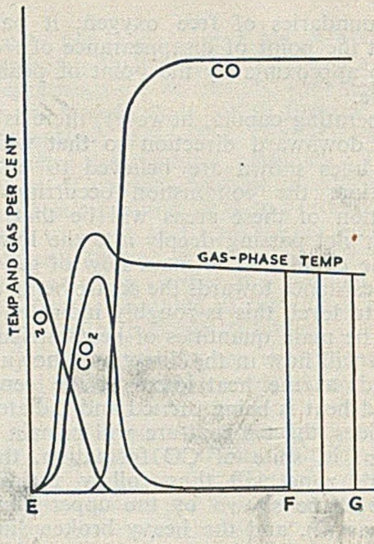
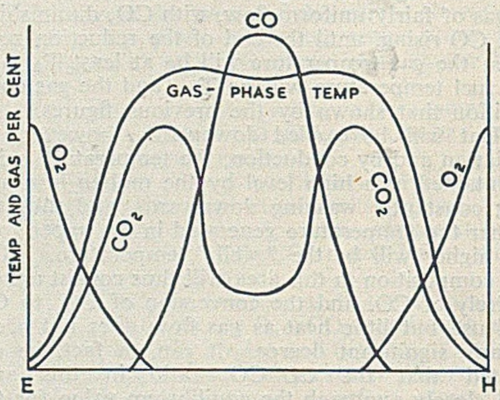


FIG. 9 (*c*).—*Gas Composition denoted by the Plane E-F-G in Fig. 9 (a).*



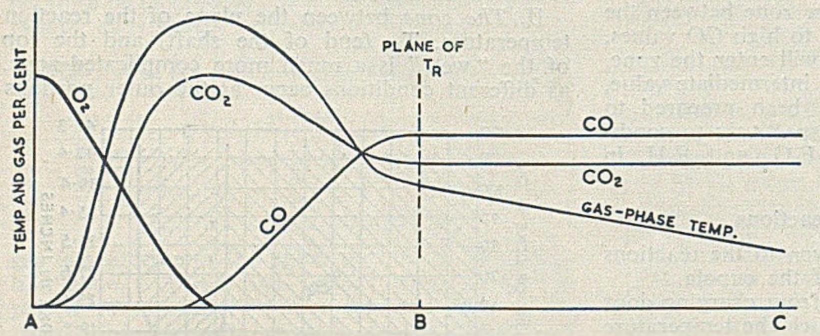


FIG. 9 (*d*) (*above*).—*Gas Composition denoted by the Plane E-H in Fig. 9 (a).*

FIG. 9 (*b*) (*left*).—*Gas Composition in the Cupola Area denoted by the Plane A-B-C in Fig. 9 (a).*

of the zone than at its centre on the one hand, and at differing levels on the other. It can be seen, by reference to Figs. 9 (*a*), (*b*), and (*d*), however, that all the elements, including iron, will be oxidized in the high-temperature zone, as the $CO:CO_2$ ratio is very low, and that this tendency will be accentuated in the parts of the furnace where metal falls through the tuyere zones 2, 2, encountering free oxygen, but, after first continuing in the centre of the furnace, it may reverse if the $CO:CO_2$ ratio rises sufficiently.

This zone will, therefore, always produce oxidation, but the degree of oxidation will be reduced by all the factors which restrict the sphere of influence of oxygen in the tuyere zones 2, 2, and which reduce the sphere of influence of CO_2 (i) in the high-temperature zone above the tuyere zones (Fig. 9 (*b*)), and (ii) especially in the high-temperature zone between the tuyere zones (Fig. 9 (*d*)). These factors are those which lead to short reaction distances, *i.e.*, fuel size, blast temperature, and high fuel ratios (the cooling effect of higher rates of iron flow for a given rate of heat production giving lower temperatures and slower reaction speeds). It will be noted that these factors are also those which lead to high reaction temperatures and high $CO:CO_2$ ratios in the stack. Small fuel size, however, increases the melting rate and lowers the metal temperature and temperatures at the cupola centre, so that it is the least desirable of these approaches.

III. *The zone* below the tuyeres where free oxygen no longer exists, and a high temperature is coupled with very high $CO:CO_2$ ratios, is perhaps the most important in the cupola, as, here, reducing conditions again obtain, and the oxidation which has occurred is reversed in some measure; the degree of this reversal, coupled with the final metal/slag reactions, will decide the final overall melting loss of the cupola. Fortunately, perhaps, the primary factors which control the efficiency of this zone as a reducing zone are obvious, and consist of high temperature coupled with high $CO:CO_2$ ratio, and as has already been shown from the form of the Boudouard curve, $CO:CO_2$ ratio rises with temperature when a system is in equilibrium, so that, in the absence of gas flow, one might say that the major efficiency of this zone depends on one factor, *i.e.*, high temperature.

Now, whilst the absence of gas flow cannot be assumed, in cupolas of very low "well" depth, in the "well" space above the slag level, the very presence of a slag serves to guarantee the absence of gas movement in the normal sense below the slag level. Yet, in and below the slag, the reactions that occur at the slag/coke interface, and the metal/coke interface, will proceed in the one direction or the other in a manner corresponding to that for a given $CO:CO_2$ ratio and temperature, as any reduction of an oxide by carbon implies the production of CO or CO_2. Furthermore, at any given temperature, there is, on the one hand, a balance between the C, CO, CO_2 and the metal oxide or metal, which, unless the whole system is in equilibrium, tends to alter the relationship between the C, CO, and CO_2, as either reduction of oxidation proceeds, and on the other hand there is a balance between the CO, CO_2 and carbon, which attempts to come to rest in accordance with the Boudouard reaction and thus to restore the $CO:CO_2$ ratio in accordance with the equilibrium for this reaction. Thus, even if the element concerned be not reduced, when the drops of oxide-coated metal, or oxide-bearing slag (tumbling over the incandescent coke), fall through the high-temperature high-$CO:CO_2$ portion of a deep-enough "well," but, instead, arrives in the slag and metal phases in the "well" (where reaction then proceeds between metal and coke, and slag and coke), the ultimate result will be similar, given adequate reaction time.

Secondary factors affecting this zone can now be realized, for instance, it is obviously desirable that the cupola-well portion should neither be so shallow above the slag surface that free oxygen or a high-CO_2 gas phase is re-oxidizing slag components at this interface, nor that the well depth should be so extreme that high heat losses unduly lower the slag and metal temperatures. The provision of adequate slag depth is also advantageous to allow sufficient reaction time between the slag and the falling drops of metal, which present much better interface conditions, due to the high ratio of surface area to weight, than does the normal slag/metal interface. It is also obvious that fluid slags are to be preferred to viscous slags; that, where possible, slags forming complex and stable compounds with the oxides to be reduced should be avoided and slags containing materials catalytic to desired reactions should be sought. Again, slags which readily remove the ash network remaining as the carbon of the coke is consumed, will improve the effectiveness of the carbon, and hence of the reduction processes. The question arises as to what reductions can take place in this zone of the cupola, either by direct oxidation of $CO \rightarrow CO_2$, or indirectly as oxide/slag/coke reactions.

(*To be continued, see References page 358 at foot of col. 2*)

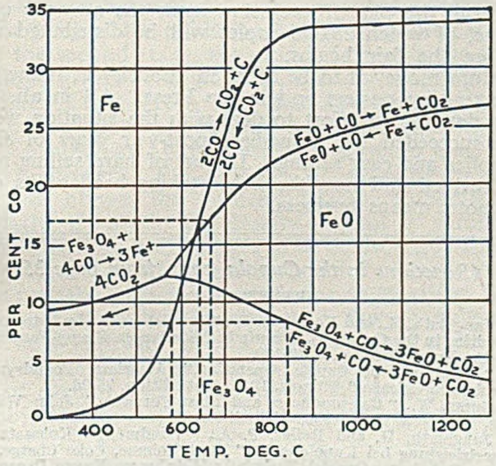


FIG. 10.—*Iron Reduction by Carbon Monoxide, superimposed upon the Boudouard-reaction Curve.*

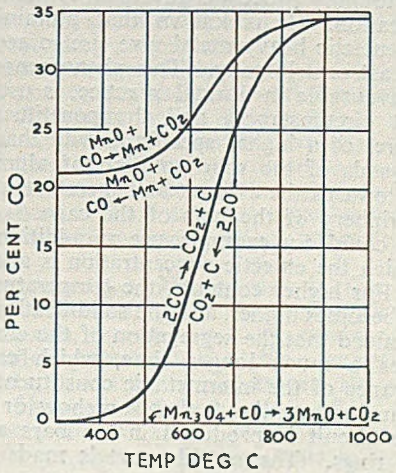


FIG. 11.—*Equilibrium Curves for Manganese Oxides reduction by Carbon Monoxide.*

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Centrifugal Casting of Rotors*

Squirrel-cage motors are used in many branches of industry, and efforts have been made to reduce the intensity of the starting current. As the search increases to establish a direct connection for these motors, it is necessary to reduce, as far as possible, the intensity of the starting current. It is possible to obtain the result with a ring motor by introducing a variable resistance in the rotor circuit, the increase of resistance decreasing the intensity of the current.

The squirrel-cage motor, by the careful consideration of the form of the grooves, (which are deep and narrow), can be given a feeble starting current intensity because the upper part of the bars alone is charged with an induced current, which increases the resistance. This effect can be heightened by using rotors with special grooves in which the conducting material located in the periphery presents a higher resistance than the material situated in the interior. The external part of the bars should therefore present a higher resistivity —which leads to the idea of a rotor carrying a double system of bars in the same grooves.

Assembly for Casting

Centrifugal casting permits of the conception of a rotor so composed, when using a machine with a vertical axis. The magnetic part of the rotor is made up as usual by an assembly of sheets carrying at their surface a series of passages into which the conductor metal is cast—this is usually pure aluminium. During casting, the central part of the machine rotates at high speed, carrying the mould and the rotor. The liquid metal is impelled to the periphery in such a way that it fills perfectly the peripheral passages. The short circuit rings are obtained at the same time and serve to feed the bars. To obtain a difference of resistivity between the exterior and interior of the bars, one can substitute for pure aluminium an alloy containing one or several heavier metals and of lower conductivity than the pure metal.

The foundry process is governed by the following specification. It is known that aluminium and a non-eutectic heavy metal give rise to segregation when cast centrifugally. This phenomenon, which is unfavourable in normal practice, is used in the present circumstances and the constituent of the structure, of a higher specific gravity than that of the crystals of the solid solution of aluminium is found towards the exterior and therefore appears at the periphery of the bars of the cage.

One could, for example, use an addition of iron, for which the eutectic concentration is about 2 per cent. For higher contents, the temperature of the liquid becomes higher, and the solidification interval so extended that the segregation of the constituents requires a much longer time, which causes the appearance of the intermetallic constituent, Al_3Fe.

It thus comes about, that somehow or other, a double circuit is produced in the bars and short circuit rings. The outside part is made up of a metal of high specific gravity and also relatively high resistivity, whereas the inner portion benefits from the good conductivity and the light weight of the pure aluminium. The peripheral parts of the rotor will thus serve the starting current and the internal portions the working current.

During the casting, it is wise to provide a slight superheat to the aluminium in order that it has the chance to decant and separate itself into constituents of different resistivities. To aid these process advantages it is equally necessary to ensure an appropriate section for the peripheral bars to help the segregation of the constituents. This process does not appear to be completely solved, for it remains necessary to elucidate the effect of numerous variables. It would seem that in particular the separation of the different constituents requires that the speed of rotation of the spinning plant should be relatively high, involving the need for a soundly constructed and robust machine. Many practical tests may still be necessary to establish the best composition of the alloys and the know-how of the process. Nevertheless, the use of the centrifugal process for this purpose is novel and well worth investigation.

* Extracted from an article by Hovst-Günter Halt in *Die Technic.*

New B.I.F. Policy

In an effort to attract more exhibitors, a vigorous campaign has been launched to tell manufacturers how they can benefit from the London sections of the British Industries Fair, which will be held from May 3-14 next year. Instead of the rather formal invitations of previous years to some 9,000 firms, for the most part past exhibitors, letters will be sent to 30,000 manufacturers. There will be much more information than before and the letters will be reinforced with the aid of the staffs of the regional offices of the Board of Trade (which is responsible for the London sections), who will for the first time add their resources and local knowledge, especially to any firm wishing to know more about the B.I.F.

A further radical change is in the reserving of space, since manufacturers will be able to choose specific sites from plans now being prepared, instead of having to bid for a certain amount of space only. The first applicants will therefore have the best sites and will not run the risk of exclusion from the advance catalogue, of which 25,000 copies will be distributed well before the fair begins.

More money is to be spent in publicity at home and overseas by posters and in the Press. All in all, this is a determined effort to deal with the situation which has succeeded the immediate post-war years of short supplies and easy selling. The art of hard selling must be revived and now the B.I.F. taking heed of its own keynote, means business.

(*Reactions in the Cupola, cont. from page* 357)

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Growth Characteristics of Ingot-mould Irons in Air and Vacuum*

By J. W. Grant, A.M.I.Mech.E.

(*Continued from page* 331)

GROWTH THEORIES IN THE LIGHT OF PRESENT OBSERVATIONS

The tests reported in this Paper have established that appreciable growth can take place in cast iron even in the absence of oxidizing influences and gases. The results, in fact, lend support to Benedicks' and Löfquist's theory that when cast iron is repeatedly heated and cooled, growth is principally due to cracking caused by differential expansions and contractions occurring during the $\alpha \rightleftharpoons \gamma$ change and the consequent solution and precipitation of the graphite.

Perhaps the most interesting observation emerging from this investigation relates to the influence of a surrounding oxidizing atmosphere. The penetration of oxygen appears to set up two opposing mechanisms affecting the course of growth, the extents of the mechanisms being dependent on the composition and structure of the metal, the size of the specimen, the rate of heating and cooling, the temperature range and the oxidizing power of the surrounding medium. In the first case, growth is caused by the oxidation of the metallic constituents of the matrix: silicon, iron and manganese. Since these products of oxidation are bulkier than the metal, an expansion takes place, the extent of which depends on the nature and quantity of the oxides and silicates formed. This type of growth is increased by stressing or repeated heating, since such treatments open up inlets for the further penetration of gases into the body of the specimen. At a later stage of oxidation, the graphite also oxidizes to a gas and diffuses out of the specimen, probably without any change in volume. Indeed, there might even be a contraction resulting from this loss of graphite which would, however, probably be masked by the progressive oxidation of the metallic matrix.

In the second stage, the oxides form a protective envelope around the graphite, thereby isolating the graphite flakes from the metallic matrix. This restricts or—in severe cases of oxidation where there is no contact at all between the graphite and the matrix—prevents the solution of graphite in the austenite above the transformation temperature. Similarly, if carbon be already present in solution in the austenite and the graphite be isolated, there is no surface on which the carbon will deposit and, therefore, the austenite transforms to pearlite; the magnitude of the volume changes is thereby reduced and little growth occurs, During the $\alpha \rightleftharpoons \gamma$ changes, the behaviour of the matrix will resemble that of carbon steel; it is known that when a steel is subjected to repeated heating in an oxidizing atmosphere, scaling takes place but no appreciable growth occurs.

Growth occurring in an oxidizing atmosphere will, therefore, depend upon a combination of the growth-promoting effect on the one hand, *i.e.*, the formation of bulky oxides, and the growth-inhibiting effect on the other, *i.e.*, the isolation effect of the graphite. It is thus conceivable that under mildly-oxidizing conditions the rate of growth would be increased either as the surrounding atmosphere approaches a vacuum, or as it becomes more oxidizing. Optimum conditions for minimum growth are therefore probably reached when the iron is partially oxidized. This may have an important bearing on the growth observed in nominally non-oxidizing and inert gases unless extreme care is taken to eliminate moisture and other oxidizing impurities. Tests have shown that growth can occur to an appreciable extent in dry, pure argon (comparable with that observed in vacuum), but that as soon as some oxidation has taken place the subsequent rate of growth is considerably reduced.

Summary and Conclusions

In the first part of this Paper, the factors affecting growth and the theories of the mechanism of growth have been considered. It is well established that growth is due to decomposition of pearlite with the resulting precipitation of graphite, and also to oxidation of the metallic constituents of cast iron. The oxidizing gases pass along the cavities between the graphite flakes and the metallic matrix and oxidize the metallic matrix in the immediate vicinity of the graphite flakes. The degree of oxidation and amount of growth occurring depends upon the composition, structure, heating cycle and nature of the surrounding atmosphere.

These causes of growth, however, do not explain all growth phenomena and the theory has been suggested by Benedicks and Löfquist that a greater part of growth during repeated heating is due to cracks or fissures formed by irreversible reactions as the iron is heated and cooled through the $\alpha \rightleftharpoons \gamma$ transformations. There are other theories that dissolved and absorbed gases play an important part in growth.

The experimental work reported in this Paper was carried out mainly on ingot-mould irons in air and vacuum, the vacuum being produced by a mercury diffusion pump backed by a rotary pump in which the pressure did not exceed 10^{-3}mm. of mercury. The work included a study of the oxidation products formed at sub-critical temperatures, growth due to repeated heating tests in air and vacuum and the effects of oxidation on the forma-

* Paper presented to the fiftieth annual meeting of the Institute of British Foundrymen.

tion and transformation of austenite. The following are the main observations and conclusions:—

(1) By annealing in air at 500 deg. C. for 30 and 60 days, some spheroidization and decomposition of the pearlite occurred. The graphite flakes near the edge of the specimen were surrounded by a dark layer of compact oxides and an outer envelope which was probably due to the oxidation of the silicon in the ferrite to silica or silicates in a very fine form (Figs. 7 and 8). Similar structures were obtained by annealing for shorter periods at 700 deg. C.

(2) Volume growths of 21 to 39 per cent. occurred in specimens of as-cast and vacuum-annealed ingot-mould iron that were repeatedly heated 100 times over the temperature range 650—900—650 deg. C. in vacuum, Table II. In another test, a growth of 80 per cent. was obtained after 300 cycles. When using a specimen of an iron/carbon ingot made from pure iron and electrode graphite, melted and solidified in vacuum, and subsequently repeatedly heated in vacuum, a growth of 44 per cent. was obtained after 300 heatings. In a similar test, the iron/carbon ingot absorbed aluminium from the alumina crucible during melting, owing to the extremely high temperature reached, and it then grew 153 per cent. by the same treatment with a reduction in specific density from 6.8 to 2.7 (Fig. 17). An austenitic iron grew only 1.6 per cent. after 100 heatings in vacuum.

These results prove beyond reasonable doubt that growth can occur from causes other than graphitization and oxidation, and that the presence of gases in any form is not essential. This lends strong support to the theory that growth can be caused by local differential expansions and contractions during the $\alpha \rightleftharpoons \gamma$ changes.

(3) By previously annealing in air, and permitting oxide to form in the iron, major growth was inhibited, but not indefinitely, upon repeated heating in vacuum. Specimens machined from blocks that had been previously annealed in air at 700 deg. C. grew from 3.4 to 5.6 per cent. after 100 cycles, 650—900—650 deg. C. in vacuum (Table II), whereas those tested as-cast or after annealing in vacuum grew from 21 to 39 per cent. by the same cyclic heat-treatment. In another test, the rate of growth of an air-annealed sample increased appreciably between the 244th and 300th cycle (Fig. 17). The growth of this sample and others that were still growing steadily after 300 heatings was stopped, however, after annealing in air for 20 hrs. at 700 deg. C. (Table V).

(4) Though a different iron was used for tests in argon, the growth of the as-cast material was greater in argon than in vacuum, and yet the growth of the air-annealed material was less in argon than in vacuum (Table II). This suggests that argon, though inert, may in some way affect growth.

(5) The microstructures of the as-cast and vacuum-annealed samples showed an unidentified "fluffy" constituent growing from the sides and ends of the graphite flakes, and there were areas within the matrix where a new constituent or cracks had appeared (Figs. 10 and 11). In specimens that had been previously annealed in air, the structure did not differ appreciably from the original annealed structure. A small amount of pearlite that had formed was mainly associated with the graphite flakes (Fig. 12). In the iron/aluminium/carbon specimen, which had grown 153 per cent., there were large, black areas around the graphite flakes (Fig. 13).

(6) The fact that so little growth was obtained in vacuum with oxidized metal suggested that oxide penetration may substantially prevent the expansions and contractions from taking place at the critical temperatures. It was verified that when an oxidized ferritic ingot-mould iron sample was held in the austenitizing temperature, the graphite did not enter into solution as readily as in a sample that had been made ferritic in non-oxidizing conditions (Table VI and Figs. 22 to 23). The pearlite formed during subsequent cooling of the oxidized sample was associated mainly with the graphite flakes (Fig. 24). In one case where a sample had been oxidized by annealing for 1,000 hrs. at 700 deg. C., an austenitizing treatment at 900 deg. C. for 16 hrs. followed by furnace-cooling produced only traces of pearlite. It appears that the annealing treatment in air provides an envelope of oxide around the graphite flakes, thereby isolating them and preventing the solution of graphite in the austenite. The volume changes will therefore be correspondingly restricted.

(7) Under repeated heating in air, 650—900—650 deg. C., scaling was severe, but the volume growth was of the same order as in vacuum. The change in microstructure was entirely different. Oxidation was severe, penetrating into the centre of the 2 by 2 in. block. Nearer the edge, the oxides had formed a continuous boundary enclosing some of the matrix and the graphite flakes. At the extreme edge, the oxide boundary had contracted further around the areas originally occupied by the now-oxidized graphite flakes, producing the appearance of "white or ferrite flakes" (Figs. 25 to 29). White flakes have also been seen in used ingot moulds and in irons heat-treated at temperatures of 700 deg. C. (Fig. 9).

(8) A repeated-heating test on a material previously tested by Rocquet and Olette[13] over the same temperature range gave a greater growth in the B.C.I.R.A. vacuum apparatus than was obtained by these workers. The fact that the qualities of the vacuum in each apparatus were nominally the same indicates the difficulties in comparing results of tests made under testing conditions only slightly differing.

The chief interest of the present work lies first in the strong support it gives to the theory put forward by Kikuta, and by Benedicks and Löfquist, to explain the mechanism of growth. Secondly, it shows that whilst oxidizing atmospheres primarily cause growth, a pre-anneal in air can also inhibit growth in vacuum. It is possible that, during heat-treatment in air, both these effects could operate at the same time.

Acknowledgments

While this work did not form part of the formal programme of the Ingot Moulds Sub-Committee of the British Iron and Steel Research Association, of which the Author is a member, some of the material employed had been specially cast by several leading ingot-mould makers in connection with that programme, and the Author wishes to acknowledge his thanks to the Sub-committee and to B.I.S.R.A.

The Author is indebted to the director and Council of the British Cast Iron Research Association for permission to publish this Paper, and particularly to the staffs of the Association's vacuum-fusion and metallographic laboratories.

DISCUSSION

Mr. Colin Gresty said growth of ingot moulds was a subject in which he had been interested for very many years, and he had noticed that Mr. Grant drew attention to earlier work and the very important effect of silicon, *i.e.*, the lower the silicon the lower the growth (excepting the very-high-silicon irons). This had made him wonder why, for very heavy castings like ingot moulds and iron of considerably lower silicon content was not used. In Table I, the silicon contents ranged from 1·32 to 1·85 per cent., but there was no doubt that ingot moulds could be cast with very much lower silicon—probably less than 1 per cent.—and still be grey.

Had the Author any views on actual carbon content in relation to growth? The second sentence of the Paper stated that growth occurred in all grey irons, but he wondered whether that was strictly correct. Was there no such thing as a non-growing iron which was still a grey iron? He had in mind sub-critical temperatures at which Thompson had found permanent contraction in one iron and no growth at all.

Mr. J. W. Grant, in reply, said that ingot moulds were made with silicon contents varying from 1 per cent. to over 20 per cent. but all were substantially pearlitic. There was sometimes a tendency for free carbide to form and even large ingot moulds with up to 20 in. wall thickness were almost entirely pearlitic. With some moulds an increase in life had been obtained as the silicon content increased from 1·5 to 2·2 per cent.

As regards the carbon content, the quantity and size of the graphite particles had an important influence on growth. In general, the growth increased with size and quantity of the graphite particles. Carpenter's work had shown that in flake-graphite irons growth increased with silicon content up to 5·0 or 6·0 per cent., whereas in contrast to this, Morgan and Norbury had obtained the lowest growth with 5 per cent. silicon, when only a small amount of graphite was present and all was in the undercooled form.

With regard to non-growing grey cast iron, he (Mr. Grant) did not think there was such a material, although some irons were more stable than others. It was true that a contraction could be registered, due perhaps to a relaxation of internal stresses, but this would be a linear contraction and there would be a corresponding linear expansion in another direction. He doubted if there would be an overall reduction in volume.

Mr. Gresty said it still did not follow that the normal ingot mould composition was the ideal.

Thermal Shocks

The Chairman, Dr. A. B. Everest, suggested that a factor to be considered was thermal shock. Ingot moulds were subject to very severe conditions in service and it had proved difficult to determine the precise properties required.

Mr. R. Lee (Brightside Foundry) said that, as the representative of an ingot-mould maker, he could possibly speak as one who had to deal with the casting of the largest ingot moulds made in this country. His firm felt that a ferritic structure was desirable for large ingot moulds in order to resist thermal shock, but experience had proved such a structure was almost impossible to produce from hematite irons. With silicon contents below about 1.85 per cent. there was a tendency for free carbides to be present, in a wholly pearlitic matrix. The same iron cast into small moulds always showed appreciable amounts of free ferrite.

Various methods to produce wholly-ferritic structures had been examined and the only consistent method appeared to be by inoculation with sand as the metal passed from the cupola to the ladle. This obviously was not a practicable proposition. If anyone present could say how one could produce a completely ferritic structure in large ingot moulds, he was more than ready to listen. So far as small moulds were concerned, good results had been obtained with 1.0 per cent. silicon irons, but it depended on several factors. Thus this composition might be satisfactory where machine stripping was practised but would be unsatisfactory where hand stripping was adopted.

It seemed to him that the Paper was really meant more for the research worker than the person engaged in ingot-mould manufacture, but there was one point he could not understand. The Author seemed to stress the fact that growth was due to cracks or fissures formed by the transformations, but he did not see how that tied up with annealing in air inhibiting growth due to repeated heating in vacuum. Whatever the medium during heating—air or vacuum—the volume changes must take place.

Lastly, in 1951, Mr. Grant in a Paper published in the *Journal* of the Iron and Steel Institute, had disagreed with the suggestion of intercrystalline cracking, and he wondered whether such a phenomenon had been masked.

Mr. Grant, in reply, said that sand additions at the cupola spout even then resulted in only a partially-ferritic mould casting. He would not like people to gain the impression that the mould became entirely ferritic.

On the question of the bursting or cracking theory, he agreed that this was not wholly

Growth Characteristics of Ingot moulds—Discussion

acceptable. The important fact to explain was that such astonishing growth could occur in vacuum where no oxidation was possible, and the possibility of the formation of cracks due to local expansions and contractions could not be ruled out. To explain the fact that growth during repeated heating in vacuum was inhibited by pre-annealing in air, it was suggested that oxide layers formed around the graphite flakes and isolated them from the matrix. The graphite then did not enter into solution with the austenite upon heating through the α to γ change and there was a smaller contraction and hence less localized stress than in an iron that had not been oxidized. Conversely, on cooling, the graphite was not readily deposited during the γ to α change and hence the localized expansion would be restricted. Since both on heating and cooling the local volume changed and resulting stresses had been reduced by isolation of the flakes, the likelihood of forming or extending cracks was likewise reduced and the overall volume growth would be small.

As regards inter-graphitic cracks, he had seen many examples of what were claimed to be cracks in the matrix of microspecimens taken from as-cast ingot moulds. These had always turned out to be thin lines in the polished microspecimens where the graphite flakes had been badly burnished due to faulty polishing. He had never seen inter-graphitic cracks in as-cast ingot moulds and had no reason to believe that they existed.

Dictates of Experience

Mr. J. Blakiston, referring to the standard type of ingot mould, said the decision to more or less standardize the silicon content had been dictated by practical experience as regards resistance to thermal shock and also mechanical shock. In the average steel plant, a mould was subject to a considerable amount of misuse. Some time ago, he had found when manufacturing ingot moulds on a large scale that the amount of superheat put into the metal prior to casting had a marked influence on the life of the mould, reflecting in some cases on the amount of growth. The metal was superheated in a cupola and then allowed to cool in the ladle to a normal casting temperature. Another fact which had occurred to him was that cast iron was sometimes used as a carburizing medium for the case-hardening of precision steel parts, using hematite borings. In an ingot mould there was transferred from the mould to the steel every time a teem took place—had that been taken into consideration?

Mr. Grant, in reply, said that a report of the Ingot Moulds Sub-committee to the British Iron and Steel Research Association was due to be submitted to the Iron and Steel Institute shortly, and this dealt with many of the factors affecting the life of ingot moulds. One of the sections dealt with melting procedure and the manufacture of the moulds, and although pouring temperature had been considered, as far as he knew, no information was available on the effect of superheating. He thought that there might be a danger of adversely affecting the graphite structure, but it was a fact that could certainly be looked into and he would bear it in mind.

He had been unable to follow the point about carbon loss, but perhaps the speaker would elaborate this point.

Mr. Blakiston explained that he had not meant that the loss would be from the whole mould but from the surface of the mould in constant contact with the molten steel, and over the life of the mould the amount of carbon loss from the surface would be considerable. He was wondering whether that would accelerate the failure.

Replying, Mr. Grant said that when it came to the life of the ingot mould many changes such as oxidation and localised cracking took place on the surface adjacent to the steel ingot and the loss of carbon was another such factor, but as far as he could see this could not be avoided. It was undoubtedly a factor that caused the surface ultimately to break up. A material that would offer better resistance to growth by oxidation and to decarburization would probably not withstand the severe thermal shock.

Relation to Actual Service Results

Mr. Blakiston remarked that one did not get these conditions in laboratory tests and Mr. Grant, continuing, repeated a remark which he had made during the presentation of his Paper, that in his opinion there was no close tie-up between most of the experimental work in that report and the behaviour of the ingot mould in service.

Dr. Riley (Staveley), congratulating Mr. Grant on his Paper, said it was excellent to have such a reasoned statement on a problem with which the industry had been faced for many years. He had been rather surprised to see the extent to which the cast iron had grown when heated in a vacuum, and presumably if the cast iron specimen had grown to that extent it would lead to the formation of cavities inside the iron, but on glancing through the photo-micrographs he had been unable to see any holes in the specimen. Was that a fact or were holes present in the photomicrographs?

Mr. Grant replied that he wished he could answer that question to Dr. Riley's and his own satisfaction. In Fig. 11 there were shown some markings on the side of the graphite flakes and on the extreme left there were a lot of inter-granular markings as well. Also, in Fig. 13, the photomicrograph of the Fe/Al/C alloy which had grown 55.8 per cent.—there were large black areas but in no case had he been able to identify that black constituent. It was not graphite and not simply holes.

The Chairman, concluding the discussion, proposed a vote of thanks to the Author which was carried with acclamation.

Last Thursday, delegates to the Royal Aeronautical Society's Anglo-American conference visited the Rolls-Royce aero-engine works at Derby, and made a tour of the works.

Mechanization of Shell Moulding

By "Dornal"

Interest amongst foundrymen everywhere in shell moulding has grown rapidly since the first F.I.A.T. report was read by an observant few in 1947. The encouragement given by the resin manufacturers who wisely recognized the possibilities of a new outlet for their products has given this new technique a great impetus and, particularly in the U.S.A., the process is now everyday practice in a number of foundries.

Shell moulding necessarily applies to the production of quantities of similar castings and this in turn involves some mechanical means of manufacture. Quite a number of designs of shell-moulding machines have emerged, but it seems to the writer they all suffer from certain disadvantages.

Included in these disadvantages there are:—Undue intricacy, unnecessary motions, long time cycles, the difficulty of obtaining even sand-dumping, complication in the withdrawal of the shell from the pattern and its subsequent handling to convey it away to the assembly and pouring area.

Desirable Characteristics

From these thoughts on the subject has arisen a clear conception of the sort of machine which would seem to meet all the criticisms which can so easily be raised against those now available. There is little doubt that this is the ultimate form into which shell-moulding machines will evolve, but it would perhaps speed the process if the various desirable features were to be enumerated:—

(1) To combine a rapid output of finished shells, irrespective of the time taken by the baking period, (which may be more with some moulds than others) the machine should be of the rotary-table, indexing pattern. This will involve a plurality of pattern stations, but the patterns can all be different, with advantage.

(2) With present designs, much waste of time and motion occurs whilst the pattern is being inverted for attachment to the dump box, turned back to allow the sand to fall on it, inverted again to allow the surplus sand to fall away and finally turned back again preparatory to baking. To save all this, the patterns should be permanently mounted face downwards.

(3) The dump box could then be mounted so that it merely rises upward to make contact with the downward-facing pattern, so eliminating a roll-over motion.

(4) The sand in the dump box could be pushed upward into contact with the inverted pattern by a pneumatic or hydraulic ram, by applying air to a rubber diaphragm such as is employed in the Taccone moulding machine or the inflation of a rubber bag such as employed in a bag press. In this way, the sand is distributed evenly at uniform pressure over the whole face of the pattern. Variation in sand density due to variations in the distance the sand has to fall on to the pattern are thus avoided; so are such complications as "venetian-blind" shutters in the dump box.

(5) After application, the pattern and its cake of sand may be indexed to the baking oven. Here, with the pattern and sand facing downwards, heat which naturally rises upwards is more readily applied to complete the baking process.

(6) When the mould is properly baked, ejection becomes a simple process. It is no longer necessary to arrange complicated forks to pick up the mould when it has been lifted by the ejector pins. Arrangements could be such that the shell drops a very short distance directly on to a rubber cross-belt which can be employed to take it quickly to the clamping and pouring area, without any handling complications.

(7) One final provision is thought necessary; the sand box must be fitted with a dust-tight lid only to be removed when sand is to be spread over the pattern face. The sand box in turn should have an enclosed feed from a sand-storage hopper. To the writer's mind, the principal objection to shell moulding is that it introduces to the foundry industry an entirely new dust-producing process unless this problem is properly tackled at the outset.

Nottingham's Smokeless Zone

Tenants of houses at Clifton, Nottingham, are an integral part of an experiment that may be followed in other parts of the country. Nottingham Corporation insists that a tenant uses "coke anthracite, or one of the manufactured solid fuels, unless he can show that smokeless fuels are not reasonably obtainable." It all started in April, 1951, when the corporation began building at Clifton, which lies to the south-west of the city, what will be virtually a new town of between 5,000 and 6,000 dwellings, together with shops and other amenities to make it self-contained. So far, rather more than 1,600 houses are inhabited, and it may be 1958 before the new town is complete.

A visitor to Clifton to-day can easily assess the progress of the experiment; no matter how many fires are burning, there is an almost complete absence of smoke. The experiment has been facilitated by the co-operation of local officials of the Ministry of Fuel and Power, who have authorized the necessary permits for supplies of smokeless fuels, and by the goodwill of the tenants themselves, many of whom, in the early stages, found difficulty in obtaining the best results from their new heating equipment. Demonstrations of the appliances and the advice of a housing inspector have, however, done much to enable tenants to play their part.

Work on the Volta River aluminium scheme in the Gold Coast Colony cannot begin before 1955, as the project must first be proved absolutely sound technically, according to the scheme's special commissioner Commander Robert Jackson. The Gold Coast Government is to appoint a national committee for th project. Dr. Arthur Morgan, first chairman of the Tennessee Valley Authority, and Prof. Arthur Lewis, of Manchester University, have agreed to act as advisers.

Machinery. A return to pre-war conditions is evidenced by the publication of a machinery catalogue by George Cohen, Sons and Company, Limited, Broadway Chambers, Hammersmith, London, W.6. Further editions will be produced three or four times a year. It is a ponderous tome running to over 200 pages, which can well be understood as there are no fewer than 25 items listed under "woodworking machinery (used)." The locality where each item is lying is announced and, for the more important items, the machine is illustrated. An essential in a catalogue of this type and size is good indexing and this has been meticulously carried out. It is reasonably certain, though not expressly stated, that this catalogue is available to readers on application to the Publicity Department, Cunard Works, Chase Road, London, N.W.10.

Portable Electric Mould-drying Stoves

At the moment, much attention is being devoted to the problem of portable drying stoves. Up to now, large moulds set in foundry floors have been dried in place by means of coke fires, while the majority of boxed moulds have, as a general rule, been heated in special drying ovens. If the consumption figures for fuel and power used in drying are compared and the tariff per unit of electricity is calculated on the basis of fuel costs, the resulting equivalent energy price works our here, as in some other cases, to a value at which electricity companies are not prepared to sell their energy. Nevertheless, if the other factors which also influence the total operating costs are taken into consideration, it becomes evident that electric drying is economical even in countries where electricity is produced exclusively from heat energy. Brown Boveri, who operate in this country through British Brown & Boveri, Limited, 75, Victoria Street, London, S.W.1, have given special attention to the drying of floor moulds and have developed an apparatus which has revolutionized drying methods in this field. The plant is illustrated in Fig. 1. With fuel-fired equipment, the hot gases are led into the "green" mould and made to pass over its inner surfaces, heat being transferred into the depths of the mould exclusively by conduction. In the new process, however, air is heated electrically in the drying unit and is then forced at considerable pressure from the inside of the mould through the sand to escape finally at the outer mould surfaces. In this way, the dying process makes full use of the hot air and consequently raises the degree to which the available heat energy is utilized from about 20 to 100 per cent., a fact which alone makes electric drying an interesting proposition. On the technical side, the ability to hold all parts of the mould at the same pressure ensures uniform drying of even the most restricted mould sections. One particular new feature of the process is that simple cores can be dried in place in the moulds. These advantages explain why

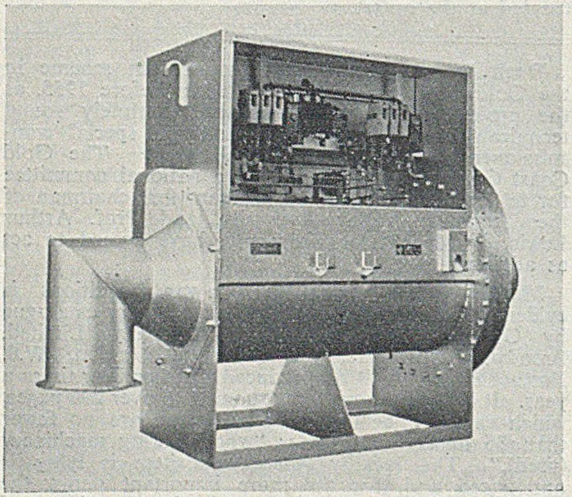

FIG. 1.—*Brown-Boveri Portable Plant for Drying Moulds by Electricity, showing the Control Equipment uncovered.*

(*Continued at the foot of Col.* 2)

Tata's Impressive Results

Despite a further substantial increase in costs, the Tata Iron & Steel Company, Limited, Jamshedpur (India), have announced impressive results for the year ended March 31, 1953. The gross profit has risen by nearly Rs. 15 lakhs to Rs. 25 crores* as a result of an increase in the gross revenue from Rs. 35 crores to Rs. 37.74 crores. Expenses have, however, continued to rise, the figure being Rs. 29.48 crores, against Rs. 26.96 crores in the preceding year.

The provision for depreciation (including Rs. 25 lakhs on collieries) has been stepped up from Rs. 2.15 crores to Rs. 2.35 crores and that for plant rehabilitation reserve from Rs. 75 lakhs to Rs. 1 crore. The tax bill is higher at Rs. 2.8 crores, against Rs. 2.67 crores. On balance, the net profit is lower at Rs. 2.1 crores, compared with Rs. 2.53 crores in the previous year.

Directors' Explanation

The directors attribute the decline in the net profit mainly to lower production and despatches of pig-iron and steel, and to the curtailment of operations at the Agrico plant owing to lack of orders. Furthermore, the previous year's profits included a non-recurring item representing retrospective increase in retention prices in respect of previous years which was only partly made up in the present year by the accretion of the post-war refund of excess profits tax and by a profit on the sale of scrap, leaving a difference of about Rs. 20 lakhs between the two years.

The negotiations with the Government for a Rs. 10 crore loan have been virtually completed, and it is expected that the company will be in a position to commence drawing on the loan shortly.

Substantial progress has been made with the modernization and replacement of plant. Work on the construction of the new Simon-Carves battery is well up to schedule, the lighting up of half the battery having taken place on July 27. The lighting of the remaining half is expected to take place towards the end of this month. Pig-iron production rose by 2.13 per cent. to 1,153,000 tons and ingot output by 0.37 per cent. to 1,061,000 tons.

Blast furnaces "A," "B," "C," and "E" were in operation throughout the year and gave a slightly higher production. "D" furnace was blown out in December, 1952, for complete rebuilding. A slackening of demand for merchant-mill materials and the rolling of a larger quantity of light sections resulted in lower production during the year in this section. The production by the sleeper plant was higher.

Iron-ore despatches rose from 1,930,000 tons to 2,030,000 tons, manganese ore from 48,000 tons to 63,000 tons, and dolomite from 22,000 tons to 26,000 tons.

The directors state that, although steel supplies available in the country are much below the real needs, lack of purchasing power and the tightness of the money market have resulted in reduced sales and accumulation of stocks.

* 1 lakh = Rs. 100,000; 1 crore = 100 lakhs; Rs. 1 crore = £750,000 approx.

box moulds as well as floor moulds can be dried on site by such units. Moreover, the great reduction in transport costs and the extra space made available in the drying ovens for smaller moulding boxes and cores, react favourably upon the economy of electric drying.

Metal Melting under Vacuum

Founders of the future may need to envisage melting and casting their metal in vacuum and in this article are recorded mechanical problems associated with the process and means at present available for their solution.

The melting of metals under high vacuum is a process of comparatively-recent development, but during and since the last world war it has progressed from the initial stages of laboratory experiments with small and makeshift equipment, until at the present time a standardized range of sizes is available having crucible capacities from 20 to 240 lb., with accompanying high-vacuum pumping equipment suitable for vacua in the order of 10^{-5} mm Hg., and there is today a plant installed in a Swiss works with a crucible capacity of 450 lb. steel.

Container

It will be appreciated that the design and construction of the outer vacuum vessel or container which surrounds the furnace proper presents a number of problems, especially in view of the fact that in a well-designed plant the melting should be carried out as far as possible under the same conditions as any other installation working at atmospheric pressure. In the case of the plant illustrated in Figs. 1, 2 and 6, which is a 60-lb. standard installation, made by the Swiss firm G.A.B., of Balzers, Liechtenstein, the container is made of stainless steel, double-cased, with a large, hinged cover, both body and cover being intensively water-cooled. In general, the time required for the production of a vacuum in such a vessel depends not only upon the internal capacity of the container, but also upon the dimensions, composition, and quality of the internal surfaces, which should have smooth and flowing lines and be capable of being cleaned readily. Some of the problems which have to be solved in the design of such a container are:—(1) The provision of means of charging the various constituents of an alloy in the proper order and at the appropriate stages in the process; (2) observation and measurement of the temperature of the melt, and (3) means for pouring the charge.

Swiss Furnace

In the design of the Swiss furnace illustrated, the problem of obtaining access to the crucible for the addition of various constituents during the progress of the melt is overcome by the provision of a supplementary 6-chamber rotating hopper, in the main cover of the container, as shown by Fig. 3. This hopper is situated directly above the crucible, and can be turned by means of an external handle so that each of the compartments can be brought successively over a charging hole, through which the contents of the compartment are dropped on to a hinged chute immediately beneath, while the actuation of another external lever allows the chute to be tipped and to slide the charge into the crucible.

Temperature Measurement

Observation of the progress of a melt is a difficult matter in a vacuum plant, because, owing to the heavy vaporisation of the charge, a normal inspection window would be quickly obscured by a metallic deposit. In the plant described, there is an inspection window of quartz glass in the hinged cover, which is reinforced internally by a second window of Pyrex. The latter is protected to a considerable extent against the deposit of metallic vapour when not in use by a movable guard, while it can be cleaned of any such deposit by a wire wiping brush operated by an external lever.

However advantageous visual observation may be the method is naturally no substitute for accurate pyrometric temperature measurement, and although

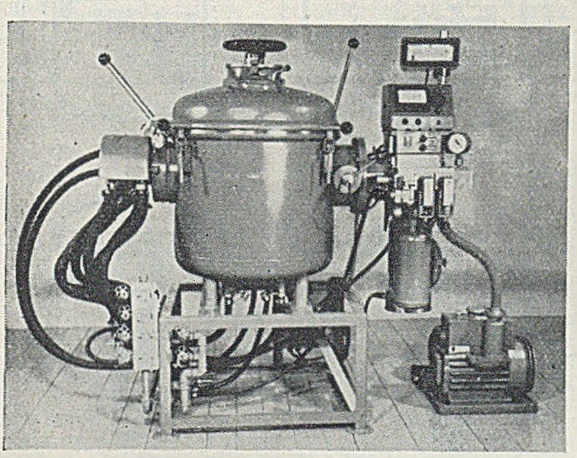

FIG. 1.—*General View of the G.A.B. Vacuum-melting Plant.*

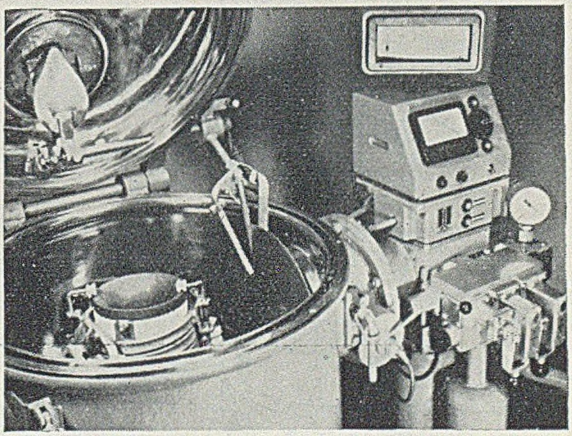

FIG. 2.—*Close-up of the Vacuum-melting Plant, with the Lid Raised and Pyrometer withdrawn.*

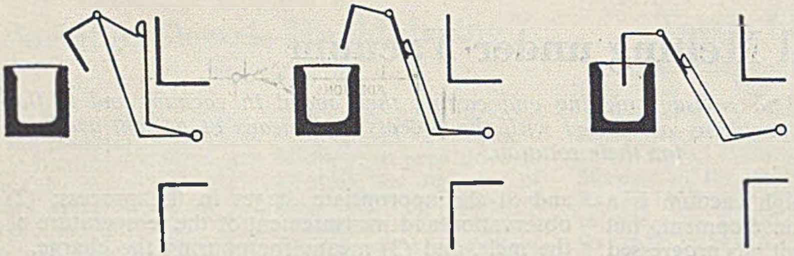

FIG. 4.—*Diagram showing the Method of Inserting the Pyrometer Tube into the Melt.*

the use of an optical pyrometer is not possible, an ingenious method has been devised for readings to be taken by a thermocouple, as shown by Fig. 2. By means of a spring-mounting arrangement, this couple (in a quartz protecting tube) is normally maintained alongside the crucible where it is not liable to either mechanical or thermal damage, and in this position does not interfere either with charging or tilting of the crucible. It is inserted into the crucible by the simple movement of an external hand-lever in the manner shown diagrammatically in Fig. 4.

Pouring

Various possibilities have been tried for pouring a molten charge of metal inside a vacuum container, some of which are illustrated by Fig. 5. In methods (*a*) and (*b*), tilting of the entire container is necessary, which involves the movement of considerable masses. In the case of (*c*) the metal is run off through the bottom of the crucible by the withdrawal of a taper plug, but this system can only be adopted in cases where it is possible to use a graphite crucible. Example (*d*) shows a German solution of this particular problem. At the bottom of the crucible is a plug of the same metal as that which is being melted, this plug being in its turn melted by an auxiliary heating coil. The method adopted in the plant shown by Fig. 1 can be seen from the sectional view Fig. 6, in which it will be noticed that it is only the crucible which tilts.

Induction heating is employed, the method permitting of the crucible being moulded and fired *in situ*. The latter is of the lip-tilting type, so that the molten charge is poured directly into the mould located immediately beneath the lip, without any necessity for movement or adjustment of the mould during the progress of pouring.

The mould material also presents certain problems in vacuum melting. In this process, it is naturally not feasible to employ sand moulds, unless it is possible for these first to be heated under vacuum and completely de-gassed, otherwise the gases disengaged in contact with the metal would be liable to result in a porous casting. In the plant illustrated, the moulds usually employed are of cast-iron or steel having perfectly smooth surfaces and preheated to some 300 deg. The ingot mould is attached to a vertical stand having adjustable arms, so that the stand will serve for a variety of moulds of different sizes. Provision is made for these to be water-cooled if necessary.

Melting Process

Fig. 7 enables the progress of a typical melt to be followed, this particular instance being the melting of 11 lb. of tool steel (0.45 per cent. C, 1.2 per

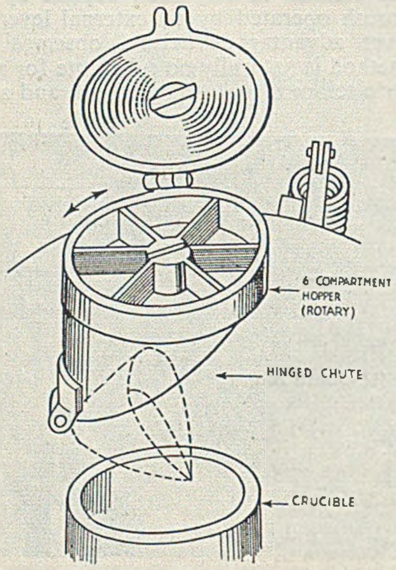

FIG. 3.—*Sketch showing the Method of Making Successive Additions to the Charge Crucible.*

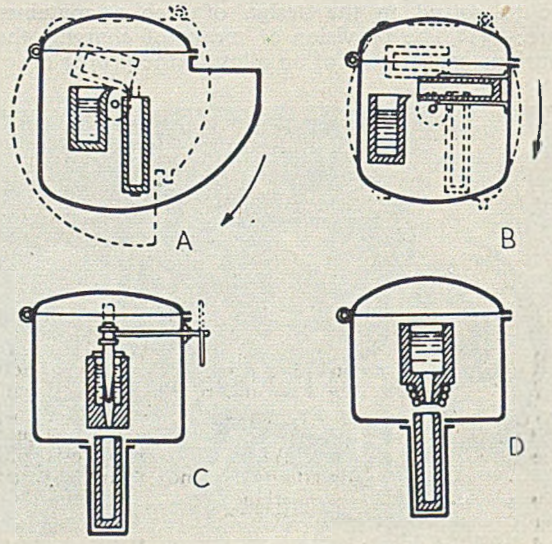

FIG. 5.—*Various Methods of Pouring which can be arranged for the Vacuum-melting Apparatus.*

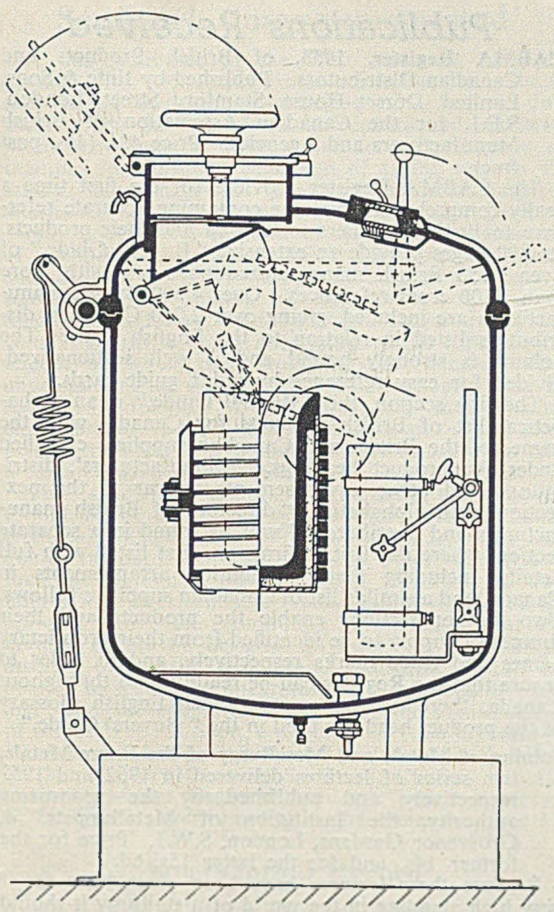

FIG. 6.—*Sectional View of the Vacuum-melting Plant.*

cent. Cr, and 0.15 per cent. V) previously melted under atmospheric pressure. The crucible employed was of magnesium oxide. Four minutes after closing the container, a pressure of 8×10^{-4} mm Hg. was reached and heating of the charge commenced. Pressure rose sharply from this point, partly due to gases given off by the crucible and partly from the charge, the pump being switched

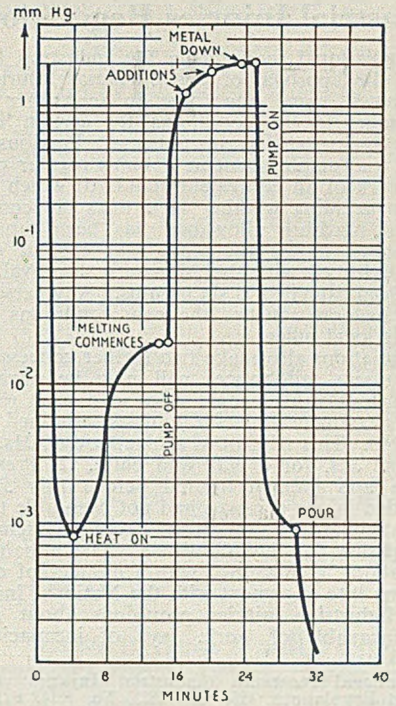

FIG. 7.—*Time/Pressure Record for a Typical Melt carried out in Vacuum.*

off immediately after the commencement of the melt as the reaction between the oxygen and carbon in the melt was so strong that metal was thrown out of the crucible. Additions to the charge were made at the points indicated, and when all the material was brought down and the melt quiet, pumping was resumed. Energy consumption for melting under a high vacuum is for all practical purposes the same as for an equivalent charge melted in the same type of furnace under atmospheric pressure, and it will be seen from the diagram that the production of the preliminary vacuum has very little effect upon the time factor, the main difference in the time taken being dependent upon the extent to which it is desired to accomplish the de-gassing of the charge.

New Industrial Democracy. Mr. Harold Watkinson, Parliamentary Secretary to the Ministry of Labour advocated the creation of a new industrial democracy between the two extremes of materialistic individualism and an equally materialistic communism, when he spoke at the opening of a summer school for young business executives at Oxford recently. He quoted an example of the kind of competition our motor-car industry was meeting with in Switzerland. In terms of English currency a French Renault cost £435; an Italian Fiat £448; a German Volkswagon £466; a British Austin Seven £546 and a British Morris Minor £539. Those figures indicated the handicap we had to overcome.

A meeting convened by local members of the Institute of British Foundrymen, is being held in the George Hotel, Luton, this evening to discuss a proposal to form a section of the London branch of the Institute, to cater specially for residents in the Luton/Bedford/Leighton-Buzzard/Dunstable area. The programme of the proceedings includes a film show by Mr. Frank Hudson, addresses by Mr. V. C. Faulkner and Mr. E. Daybell (chairman of the local committee), followed by general discussion of the project. All foundrymen in the area who are interested should write to Mr. W. Twaddle, acting secretary, 108, Great Northern Road, Dunstable, Bedfordshire.

Industrial Injuries Regulations

New regulations* made under the Industrial Injuries Act, with the approval of the Industrial Injuries Advisory Council, came into force on September 2 and made changes in the conditions for certain benefits under the Industrial Injuries Scheme. Previously, the period of trial employment in a man's regular occupation (or work of an equivalent standard) which can be ignored in deciding whether he satifies the conditions for special hardship allowance has been limited to three months, unless the work was carried out on medical advice or with the Minister's approval. This has now been extended to six months. Any person who considers he now satisfies the new conditions should consult his local office.

The regulations also make two further concessions:—(1) Dependants' allowances will now be payable to certain unemployable people who have been receiving workmen's compensation for injuries sustained before July 5, 1948. This will mean an increase of 21s. 6d. for a wife, and 32s. for a wife and child. (2) Previously, policemen and firemen injured before July 5, 1948, and awarded injury pensions had not been able to draw constant-attendance allowance; from September 2 the will qualify for this allowance. The remainder of the regulations is concerned with a number of changes which bring into alignment with the National Insurance Act the Industrial Injuries provisions about persons deemed incapable of work, days of incapacity and night-workers.

* The National Insurance (Industrial Injuries) (Benefit) Amendment Regulations, 1953, S.I. 1953, No. 1314. Price 4d.

New Catalogues

Flame-proof Motors—Newman Industries Limited of Yate, Bristol, have just issued a 32-page well-illustrated catalogue covering a wide range of flame-proof motors. It contains a number of tables giving useful data and characteristics of the various types and sizes. Usually this type of plant is found in mines, chemical works, and other places where there is a risk of explosions.

Cable Fastenings. By assembling segments between the strands before inserting the wire into a sleeve—a patented system—an attachment has been developed for making self-locking fastenings on steel cable and is described and illustrated in an eight-page pamphlet issued by E. H. Bentall and Company Limited, from their cable-fastenings department, 59, Broad Street, Worcester. The message of this booklet is reinforced by the inclusion of a reprint of a paper by Mr. T. E. Dimberley to the Institution of Mechanical Engineers (Midlands branch) and by a test report undertaken by the Industrial Research Laboratories Birmingham. Excellent findings have been described. These documents are available to readers on writing to the Worcester address.

Shot-blast Equipment.—When folders are used for publicity purposes, they should be kept as simple as possible, otherwise pages appear upside down and even may be missed. One from Guyson Industrial Equipment Limited, North Avenue, Otley, near Leeds, has rightly avoided complications by using a plain six-page folder covering shot-blast cabinets, an air compressor and a dust extractor. Two models are illustrated, the larger one having a 32 in. by 22 in. by 29 in. chamber and the smaller 20 in. by 20 in. by 28 in. They are equipped with a motorized dust extractor and work at 50 to 150 lb. per sq. in. The chamber illumination is by 100-watt lamp. The folder is available to readers on application to Otley.

Publications Received

CABMA Register, 1953, of British Products and Canadian Distributors. Published by Iliffe & Sons, Limited, Dorset House, Stamford Street, London, S.E.1, for the Canadian Association of British Manufacturers and Agencies. Price 42s. (44s. post free).

The CABMA Register provides for the first time a really comprehensive volume containing accurate reference to British suppliers to Canada and their products. Its 800 pages provide an extensive " Buyers' Guide " of over 3,750 British manufactured products, with more than 1,300 cross references. Over 4,500 British manufacturers are included, giving over 2,750 Canadian distributors listed in relation to the English firms. The volume is strongly bound and is well sectionalized, divided for easy reference by index guide cards.

The first section, the " Buyers' Guide," is an alphabetical list of British products for Canada, with the names of the British and Canadian suppliers classified under the product headings. Manufacturers', distributors' and other advertisements appear in the next section. An alphabetical " directory of British manufacturers and distributors " will be found in a separate section, where the British firms are first listed with full details, including their distribution arrangements in Canada, and a similar list of Canadian suppliers follows. Two further sections enable the products and their sources of supply to be identified from their proprietary names and trade marks respectively, and in order to ensure that the Register can be readily used throughout Canada, there is a complete French/English glossary of the product headings used in the " Buyers' Guide."

Joining of Metals and Metallurgy of the Rarer Metals, two series of lectures delivered in 1952 and 1953 respectively and published by the sponsoring authority, the Institution of Metallurgists, 4, Grosvenor Gardens, London, S.W.1. Price for the former 14s. and for the latter 15s. 6d.

Because these lectures have been given by men of very high standing in the world of metallurgy it should not be thought that they are high-brow. On the contrary, they are not only easily understood by the average of those in the profession but they are, in many cases extraordinarily interesting. By the time a technical man has been practising in one field for a number of years, knowledge of those far remote becomes hazy, if indeed it was ever acquired. The opening lecture of the " Joining of Metals " series, by Professor O'Neill, produces the first list the reviewer has ever seen of all the methods and processes that have been or are used for joining metals. When thinking about " burning-on " one would indeed be unlikely to associate the making of Sheffield plate as entering into the same category. The rest of the lectures deal with various phases of welding, soldering and brazing and the determination of weldability.

The second series of lectures deals with the very subjects on which but few are really knowledgable, and in most cases reliance has been made in the past on text-books written by people only well versed in a fraction of the fields covered in their bulky tomes. In the series under review, however, detailed consideration has been given to the metallurgy of uranium; beryllium; molybdenum; tungsten; titanium; zirconium; tantalum; niobium; chromium; manganese and the platinum group. Dr. Chaston, when dealing with tantalum and niobium has recalled the discovery of these elements and shows how the designation " columbium " for " niobium " is historically correct. This is the type of book which will be treasured by all metallurgists who take a broad interest in their profession.

Sandwich Courses Suggested

A sub-committee of the West Midlands Advisory Council for Technical, Commercial and Art Education which has been considering how best to implement the findings of the universities and industrial productivity reports which called for an expansion of facilities for full-time education of young men in industry, has suggested that "sandwich" courses—alternating college attendance and industrial experience—may provide the solution of the country's shortage of technologists. They define the object of such courses as "the provision of technologists of adequate standard whose training has been developed in close touch with industry" and "adequate standard" in this context means a broad knowledge of the fundamental science on which their technology is founded, some understanding of the historical and economic basis of society in relation to industry, and the personal characteristics, powers and expression and social competence necessary for a man to play an effective part in an industrial organization.

The "sandwich" courses, the committee recommends, should be developed by one or more selected major technical colleges, chosen on the grounds of an adequate standard of staffing, and other educational facilities combined with sufficient facilities for corporate life. Residential accommodation should be the ultimate aim. The committee recommends that the courses should be designed to meet the needs of industries within the region and industries should cooperate to secure the integration of the periods of training. The sub-committee was under the chairmanship of Major W. F. F. Scott, a director of Tube Investments Limited and Accles & Pollock Limited. The chairman of the Advisory Council, Sir Hugh Chance, and the chairman of the Regional Academic Board, Professor F. H. Garner, were among its members.

Steel Output Record

Steel production in August, which was again affected by holidays, averaged 291,400 tons a week and reached an annual rate of 15,155,000 tons. This was the highest August figure ever recorded and it compared with a weekly average of 279,500 tons in August, 1952, when the annual rate was 14,535,000 tons, which was itself a new record for the month. The effect of holidays last month was less pronounced than in the corresponding month a year ago.

The output of pig-iron last month also constituted a record for August; it averaged 204,400 tons a week, against 201,900 tons a week in August of last year.

Latest steel and pig-iron output figures (in tons) compare as follow with earlier returns:—

—	Pig-iron.		Steel Ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
1953—July ..	202,400	10,524,000	276,600	14,383,000
August ..	204,400	10,629,000	291,400	15,155,000
1st half year	213,500	11,102,000	347,600	18,074,000
1952—July ..	201,600	10,482,000	273,800	14,236,000
August ..	201,900	10,498,000	279,500	14,535,000
1st half year	199,900	10,397,000	308,000	16,046,000

ROOD END FOUNDRY COMPANY, LIMITED, has had plans approved to carry out extensions to the foundry in Tat Bank Road, Rowley Regis.

Rehabilitating Disabled Workers

There are at present 14 industrial rehabilitation units in operation in this country. A new type of unit which is to be opened by the Ministry of Labour at Waddon (Surrey) in December will differ from the existing centres in that it will undertake special research into the rehabilitation of disabled workers as well as the provision of training and exercises. The research will be directed by the suggestion of the Industrial Rehabilitation Development Committee that success in placing people in employment after a course at a rehabilitation unit should not be the sole measure of the value of the unit's methods. The committee recommended that a way should be found of rating scientifically in physical and psychological terms the "employability" of a worker when he comes to the unit. It could then be ascertained if he was likely to profit by the course or, if it had been taken, how much good it had done.

The units cater mainly for industrial workers who come to them when they leave hospital, but they also take a few disabled and crippled people who have never worked before. Many of these are trained so that they can live in a normal community and support themselves from their own earnings. Of those who complete a course, more than two-thirds find jobs or begin training as skilled workers within three months of leaving the unit.

Exports from Small Firms

Encouragement to small firms to enter overseas markets is advocated by the Select Committee on Estimates, which has just issued its thirteenth report. British export trade, it is emphasized, would rest on a much broader foundation if many more small firms could be induced to take active interest in overseas markets; in addition, the volume of the trade would be increased. The committee suggests that the Board of Trade's services to the smaller manufacturers should be improved, and it gives two suggestions as to how this might be achieved.

The first is that the Board of Trade should concentrate on familiarizing small firms with the particulars of the services it provides for exporters, and the second is that it should publicize more effectively its practice of obtaining samples of the products with which British products would have to compete.

Index to Volume 94

The index to the JOURNAL, volume 94, covering the period January 1 to June 25, 1953, has now been printed and is available to readers free of charge. Applications for copies should be addressed to the publishing office, FOUNDRY TRADE JOURNAL, 49, Wellington Street, London, W.C.2. Subscribers who wish to receive copies of indices automatically as they are printed may apply for inclusion on a permanent mailing list.

TWO 64-IN. ELECTRIC LIFTING MAGNETS were ordered by a Canadian firm from the Witton-Kramer Electric Tool and Hoist Works of the General Electric Company, Limited, for loading scrap iron into ships at Montreal Pier. Only fourteen days after the order had been received in England the magnets were in service in Canada, and within less than three weeks of the date of despatch from Birmingham, they had handled 2,500 tons of scrap iron for shipment to this country. Since that time, four further magnets, one 64-in., two 36-in. and one 26-in. dia., have been delivered at Montreal with equal promptitude.

B.S.C.R.A. Radiographic Exposure Calculator

The British Steel Castings Research Association has recently developed a radiographic exposure calculator for use with the isotopes cobalt_{60} and iridium_{192}, materials which are now commonly employed for industrial radiographic purposes in steel foundries and elsewhere. The calculator can also be used in conjunction with radium or radon, and scales are included which permit allowances to be made for the relatively rapid decay of radon and iridium sources. The calculator will fill a long-felt want for a rapid and reliable means of ascertaining radiographic exposure times, when using the artificially prepared radiographic sources in particular.

The calculator, the prototype of which is illustrated in Fig. 1, is in the form of a plastic, pocket-size slide rule and consists essentially of two fixed scales and two sliding scales, the bottom one of which is locked in a position determined by the type of film in use and the film density required. This position is determined by setting the appropriate density index mark on the bottom fixed scale against a "film factor" on the bottom movable scale. In routine work, this setting will not normally be disturbed, unless for any reason the type of film in use is changed, so that the majority of exposure calculations will be carried out by appropriate setting of the upper movable scale only. This scale is reversible, the side employed being determined by the isotope in use. Its setting correlates the four variables, source strength, source to film distance, steel thickness and exposure time. The setting of the rule may be adjusted to the film density requirement of the user, and includes scales for calculation of radon and iridium decay as well as one which gives the thickness of steel which, for the purpose of setting the rule, may be employed when examining materials other than steel.

The exposure calculator is clearly of interest in industries other than steelfounding, and it is now in course of manufacture in sufficient quantity to render it available outside the membership of the Association. Enquiries should be addressed to the Association at Broomgrove Lodge, Broomgrove Road, Sheffield, 10.

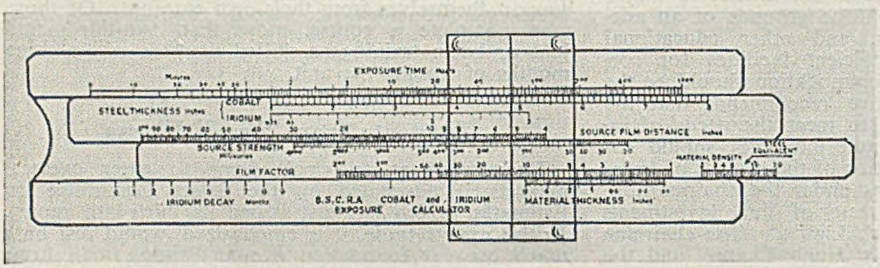

FIG. 1.—*Prototype of the B.S.C.R.A. Radiographic Exposure Calculator (Copyright).*

German Foundrymen's Convention

The German Foundry Technical Association (Verein Deutsche Giesserufachleute) is holding a convention in the Robert Schumann Hall, Düsseldorf, on Friday and Saturday, October 9 and 10. The first session, starting at 9.30 a.m., with Dr. F. Grosser in the Chair, opens with a paper on the "Influence of Work Study on Production in Foundry Practice" by Mr. M. Forster. He is to be followed by Professor Piwowarksy on "Influence of Magnesium on Low-carbon Steel Castings." The third lecture is by Dr. Schwietzke on "Gas Porosity in Non-ferrous Castings—Gassing and Degassing of Melts." This session concludes with a colour film dealing with "Feedex" to be presented by Dr. Lanzendörfer.

The afternoon session, starting at 2.30, is to be presided over by Dr. H. Timmerbeil. The opening lecture is by Dr. P. Schneider, who will present two American films on "Running and Risering." Next, there is a paper by Dr. K. Sauerwein on the "Use of Radioactive Isotopes and their Application to Foundry Problems" (with demonstration). The final lecture is by Professor K. Roesch, who will present a "Critical Study of Non-destructive Testing." In the evening there is to be a supper-dance at the Rhein Hall (formerly the Plantetarium).

Mr. R. J. H. Küster presides at the Saturday morning session, which is to start of 9.45 a.m. First, there will be the annual general meeting, and following this, Professor E. Gutenberg is to lecture on "Some New Phases of Industrial Costing." The final lecture is by Professor Chr. Gerthsen on "Some Applications of Cosmic Rays." A suitable programme has been arranged for the entertainment of lady guests.

House Organs

Perkins News. Summer 1953. Issued by F. Perkins Limited, Peterborough.

This issue is primarily devoted to illustrated stories all connected with the 21st birthday celebrations of the company. The graphs of progress incorporated are very impressive, for from very small beginnings, a turnover approaching £12,000,000 was achieved by 1952.

Mettle. Summer, 1953. Published by the Marshall Organisation, Stafford House, Norfolk Street, London, W.C.2.

There are two articles of importance in this issue. The first deals with the growth of combine harvesters in this country, and shows how it has increased. From fewer than 2,000 in 1943 the total reached over 19,000 in 1952 and now home manufacturers have captured the bulk of the market. The second article is a necessary consequence, and that is the subject of stock holding for distribution of spare parts.

Ruston Overseas News. Vol 2, No. 14, August. Published by Ruston and Hornsby Limited, Lincoln.

As this very well produced magazine is for the enlightenment of overseas agents and customers, it was only to be expected that the Coronation should figure prominently and a feature article on this has been excellently carried out. There is a long, well-illustrated article on foundrywork by Mr. R. C. Shepherd, who includes some data on shell moulding. The reviewer learnt with interest that an iron filigree fruit dish illustrated was of German origin, but the sample which he possesses was made in Essex! The balance of the contents has been well chosen to serve the policy of the publishers.

B.C.I.R.A. Method of Clamping Shell Moulds

Since the introduction of shell moulding, the joining of the half-shells to form the complete mould has presented difficulties. In joining shell moulds cast horizontally the clipping of the halves together and weighting them if necessary is effective, but vertically-cast moulds need a more rigid form of clamping. Various methods of joining shells cast in a vertical position are used. They include clipping the edges together with wire clips or wedge clamps; glueing the shells with quick-setting resin; bolting them together and mechanical clamping with a vice. Each of these methods has its disadvantages, and whichever is used it is possible for the operations necessary to take longer than the actual production of the shells.

To overcome the shortcomings of previous methods, a new method of joining the halves of shell moulds for vertical pouring has been developed by the British Cast Iron Research Association and is being demonstrated at the current Engineering and Marine Exhibition. It consists of a mechanical clamp comprising two sets of freely-sliding pins, as shown diagrammatically in Fig. 1.* The complete shell mould is placed between the sets of pins and they are then forced forward by compressed air so that they adjust themselves to the contours of the shells. In this way, the entire mould area is supported uniformly and rigidly during pouring, distortion is minimized and there is less flash on the casting.

Construction and Operation

The clamp is constructed in the form of two rectangular hollow chambers which face each other. In the facing surfaces, a regular pattern of holes is drilled, each hole being fitted with a sliding steel pin. Compressed air can be supplied to each chamber and when the air is admitted the pins are forced forward, each pin giving the same thrust, proportional to the cross-sectional area of the pin and the air pressure used. One of the chambers is fixed but the other is movable, being connected to the piston of an air cylinder of 6-in. stroke.

In operation, the movable chamber is brought to its forward position, nearest the opposing chamber, and the pins of both chambers are retracted. The complete shell mould is placed between the two sets of pins and compressed air is admitted into both chambers. The pins move forward and adjust themselves to the contour of the shell, locking the halves together ready for casting. When the casting has solidified, the air pressure is released in both chambers and the movable chamber is retracted so that casting and mould drop away and can be removed.

The advantages claimed for the new method are that all preliminary work normally involved in securing the half-shells together is avoided, distortion and flash are reduced because the shell mould is held uniformly over its whole area, and only sand and castings have to be separated after casting is completed. An additional advantage of the method is that slightly-warped shells can be properly registered and clamped satisfactorily.

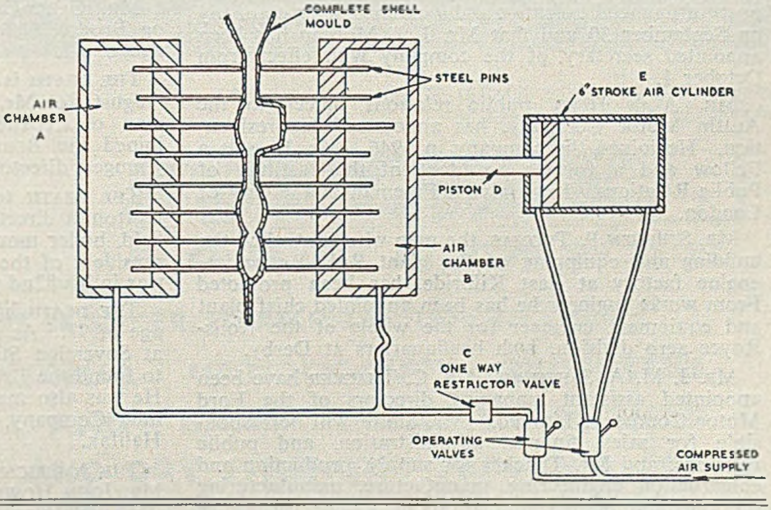

FIG. 1.—*Diagrammatic Section through the Pneumatic Clamping Arrangement for Shell Moulds developed by the British Cast Iron Research Association.*

* Abstracted from the B.C.I.R.A. *Journal of Research and Development.*

A 35-h.p. Two-stroke Engine made in 1913 by Levis, Limited, Stechford, for an ultra-light aeroplane has been removed from the works stores at the request of the Science Museum, South Kensington, and will shortly be displayed there in the aeronautics section. The plane—a monoplane with triangulated wings—was assembled at the Levis works and made its only flight at Castle Bromwich playing fields, which later became the aerodrome. Recently the Levis company (who now make air compressors), built from old parts, for the Science Museum, a 1915 Levis motor-cycle, the belt-driven 211 c.c. model. The plane engine has its original Bosch box magneto and has been mounted on a tubular steel stand.

Nickel/Molybdenum Alloys.—Adding molybdenum to nickel or to nickel containing small percentages of iron, produces alloys which are strongly resistant to corrosion by hydrochloric and phosphoric acids, and to a lesser extent by sulphuric acid. The initial work on these alloys was done in the United States and Germany, and in the form of castings the alloys have been produced in this country for some years. Wrought forms are required, however, often for use in conjunction with castings, and for those interested Henry Wiggin & Company Limited, Birmingham, have begun the manufacture of material of this type under the name of "Corronel B".

Personal

MR. ARTHUR D. BAILEY has been appointed manager of the Newcastle-upon-Tyne branch of Brook Motors, Limited, Huddersfield.

MR. W. G. PAVITT has resigned from his position as a director of Brown Bros., Limited, hydraulic and general engineers, etc., of Edinburgh, after 56 years' service with the firm.

MR. JAMES STEEL, joint managing director of Steel & Company, Limited, engineers, etc., of Sunderland, leaves Britain on September 26 for a 10-week tour of the U.S.A. and Canada.

MR. A. R. NEELANDS, chairman of the Cementation Company, Limited, group, is now visiting Canada to inspect operations and to consult with the managing directors of the Canadian subsidiary companies.

MR. M. K. ARNOTT has relinquished the secretaryship of the British Oxygen Company, Limited, on his appointment to a higher position within the organization. MR. H. COBURN has been appointed secretary of the company.

MR. J. D. DOBSON, who has for several years been connected with the Iron and Steel Division, Ministry of Supply, is now with the new Iron and Steel Board, temporary address, 21 to 24, Grosvenor Place, London, S.W.1 (telephone, SLOane 9686).

MR. R. A. RIDDLES is retiring on September 30 from his position on the Railway Executive, where he has been responsible for the mechanical and electrical engineering activities. He was formerly a vice-president of the London Midland and Scottish Railway.

BRIGGS MOTOR BODIES, LIMITED, announces that MR. S. W. KALLEND is relinquishing his directorship and his posts of financial executive and secretary of the company on September 30 and that Mr. J. I. Morgan has been appointed secretary of the company with effect from October 1.

MR. ALAN HESS, public relations officer to the Austin Motor Company, has announced his resignation. He joined the company in 1946. Mr. Hess is a Fellow and a former president of the Institute of Public Relations. He is also a Freeman of the City of London.

MR. STEPHEN P. THOMAS, the man who controlled the building and equipping of the giant Rolls-Royce jet-engine factory at East Kilbride, has been promoted From works engineer he has been appointed chief plant and equipment engineer for the whole of the Rolls-Royce aero division, with headquarters at Derby.

MR. J. M. A. SMITH and MR. C. THACKER have been appointed assistant managing directors of the Ford Motor Company, Limited. Mr. Smith will be responsible for sales, finance, administration, and public relations; and Mr. Thacker for supply, production and construction engineering, manufacture, manufacturing services, and industrial relations.

MR. E. CARNEGIE and MR. J. SMITH have resigned from the board of Sentinel (Shrewsbury), Limited, manufacturers of Diesel engines, locomotives, etc., which is a subsidiary of Metal Industries, Limited. Both Mr. Carnegie, who was chairman of the company, and Mr. Smith have reached the statutory age of retirement from the board. Mr. Smith has been in the company's service for 50 years.

MR. A. G. B. OWEN was again elected president at the annual conference in Sheffield of the National Trade Technical Society. He is a prominent member of the South Staffordshire section of the Society. MR. W. H. DAVIES, also of the South Staffordshire section, was elected treasurer. The Derby section won the cup given by the president at the sports which took place during the afternoon of the conference.

The retiring steel plant manager of the Cargo Fleet Iron Company, Limited, Middlesbrough, MR. ROBERT BURNETT, has been presented with a gold watch by Mr. E. Marriott, chairman of the Cargo Fleet No. 1 branch of the British Iron, Steel and Kindred Trades Association. Mr. Burnett has been with the company 42 years, for 31 of which he was steel plant manager. He is taking on a less arduous task in the laboratory.

THIS YEAR, Mr. Kenneth Bridges, managing director of F. W. Bridges & Sons, Limited, celebrates his fortieth anniversary as an organizer of trade exhibitions, which annually attract thousands of visitors to Olympia, Earls Court and other big exhibition venues. A score of his friends who have long been associated with him in the business of organizing more and bigger exhibitions than anyone else in the world, entertained him to luncheon just before the opening of the 19th Engineering Exhibition at Olympia. This exhibition which closes to-day, is the twenty-first that Mr. Bridges has organized since the end of the war. Mr. Bridges revealed at the luncheon that the first exhibition he personally supervised was in the pottery town of Stoke-on-Trent, in 1913. He was seventeen at the time. Mr. Kenneth's father started the family business in 1896, when he staged several exhibitions at the Royal Agricultural Hall, Islington.

Obituary

THE DEATH is announced of Mr. Norbest Coolens, of Les Fonderies Coolens, Mont St. Amand, Belgium.

MR. CARL CHRISTENSEN, of A/S Carl Christensen og Brodre, Oslo, Norway, died on August 25 at the age of 72.

THE DEATH is announced of Mr. F. P. I. Crossley on August 26. Mr. F. Crossley, the grandson of the chairman of Crossley Brothers, Sir Kenneth I. Crossley, joined the Board in September, 1950, and was the youngest director.

THE DEATH took place last Thursday of Mr. C. J. Hofton, a director of Hopkinson, Limited, of Huddersfield, boiler mountings manufacturers. He was a past-president of the Nottingham Society of Engineers and was in his 82nd year.

THE DEATH has occurred of Mr. Frank Ford, at the age of 77. As a manufacturer of restaurant equipment at Sovereign Street Works, Halifax, Mr. Ford helped to found the British Range Makers' Federation in 1933. He was also managing director of Halifax Metal Spinning Company, Limited, metal platers, of Boothtown, Halifax.

THE AMERICAN TECHNICAL PRESS reports the death of MR. JOHN HOWE HALL, aged 72 years, the well-known steel metallurgist and author of "The Steel Foundry." He was an honorary member of the American Foundrymen's Society and the first recipient of the J. H. Whitney Gold Medal. A graduate of Harvard, he spent his whole working life in the steel foundry industry, either in the works or as a consultant.

MR. EDWARD PACEY, general secretary since 1923 of the National Union of Operative, Heating, Domestic and Ventilating Engineers and General Metal Workers, died in Birmingham last week. He was 66. Mr. Pacey was also a member of the executive council of the Confederation of Engineering and Shipbuilding Unions and was recently elected vice-president of the National Joint Industrial Council for his industry.

News in Brief

THE DUCHESS OF GLOUCESTER is to open the new Denbighshire Technical College at Wrexham on November 11.

THE DIRECTORS of Henry Hope & Sons, Limited, Smethwick, have appointed Mr. Patrick Beesley a director of the company.

TYNEMOUTH CORPORATION has completed protracted negotiations for the purchase of the nearby Cullercoats Harbour from the Duke of Northumberland.

BEESTON (NOTTS) COLLEGE OF FURTHER EDUCATION, which is to open shortly, is to have courses specially designed to meet the needs of the light engineering and building industries in the area.

THE ADDRESS of the Newcastle-upon-Tyne area sales office of the Northern Aluminium Company, Limited, is now Groat House, Collingwood Street, Newcastle, 1 (telephone: Newcastle 20878/9).

THE LAST of seven shipments of heavy scrap raised at Scapa Flow, totalling 1,450 tons, left Orkney at the week-end. Salvage work will be resumed next year as soon as weather conditions permit.

A "WARMER HOMES EXHIBITION," organized by the Farnham Joint Service Committee of the Coal Utilisation Council, will be held at the Central Hall, South Street, Farnham, on October 1, 2, and 3.

THE JAPANESE MINISTRY OF TRANSPORT has announced that Japan will build 300,000 tons of shipping for domestic owners next year—five times the tonnage built for domestic use two years ago.

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE has widened the scope of the management section of its Department of Commerce. New courses are to be held to train men for executive positions in industry.

THE BRITISH WELDING RESEARCH ASSOCIATION announces that the fourth Annual School will be held at Ashorne Hill, near Leamington Spa, Warwickshire, from Monday, June 14, to Saturday, June 19, 1954.

AS FROM SEPTEMBER 19, the London address of Clarke, Chapman & Company, Limited, manufacturing marine and electrical engineers, etc., will be Dunster House, Mark Lane, E.C.3 (telephone: MINcing Lane 8345).

THE SCOTTISH BOARD FOR INDUSTRY is to convene a meeting at Grangemouth this month with a view to setting up a productivity committee for the Grangemouth and Falkirk area. Industrialists in the area are to be invited to attend.

PLANS HAVE BEEN APPROVED for proposed factory alterations at Hartlepool (Co. Durham) trading estate for John B. Pillin, Limited, makers of lubricating equipment and air compressors. The scheme will link three existing factories into one.

MR. B. L. PERKINS, B.SC.(ENG.), A.M.I.E.E., general sales manager, Foster Transformers, Limited, left this country on September 10 to make an extensive business tour of East and South Africa on behalf of the company and others in the Lancashire Dynamo Group.

THE DIRECTORS of Thomas Tilling, Limited, announce that a controlling interest has been purchased in Bagshaws & Company, Limited, of Dunstable, manufacturers of malleable iron chains and castings and of conveyor and elevator equipment, established in 1892.

THE EDUCATION COMMITTEE of the Incorporated Plant Engineers announces that for the coming winter session it has arranged a comprehensive refresher course, comprising 20 weekly lectures, to be held at Leeds University on Thursday evenings, commencing on October 15.

RESOLUTIONS to enable the Brush Electrical Engineering Company, Limited, to offer its ordinary stockholders 940,000 new 6 per cent. £1 cumulative convertible redeemable preference shares have been passed at an extra-ordinary meeting of the company. Letters of offer have been posted.

THE DIRECTORS of W. H. Dorman & Company, Limited, manufacturing engineers and ironfounders, etc., of Stafford, propose to distribute to ordinary shareholders one new fully paid 2s. share for each ordinary 2s. share held. Ordinary capital at present in issue totals £29,600.

ISRAEL hopes to be exporting copper from the legendary King Solomon's mines in the southern desert within two years. There are 100,000 tons of proved reserves in the area with an average copper content of 1.4 to 1.5 per cent., according to Dr. Joseph, the Israeli Minister for Development.

YELLOW NATIONAL INSURANCE CARDS finished on September 6. Employers and insured persons holding yellow cards are reminded by the Ministry of Pensions and National Insurance that they should be exchanged for new cards at a local Pensions and National Insurance Office this week.

A VIRGIN DEPOSIT of lead ore discovered below Riber Hillside, Matlock, is claimed to be the most important find of the century in the Derbyshire lead-mining field. Tunnelling operations by Matlock Lead Mines, Limited, have led to the striking of ore in a bed of limestone 450 ft. below the surface.

AT A MEETING of the Tees-side advisory committee of the Northern Regional Board for Industry it was reported that during May, June, and July factory extensions covering 151,336 sq. ft. were sanctioned on Tees-side. These are expected to result in employment for another 52 men and 215 women.

A FURTHER REDUCTION in the number of unemployed in the Greater Birmingham area was reported to the Employment Committee at its quarterly meeting on September 10. The number registered on August 10 was 3,455 men and 1,736 women, a reduction of just under 200 compared with the returns on July 13.

AN ALUMINIUM BRIDGE being built for Aberdeen Harbour Commissioners by Head, Wrightson & Company, Thornaby-on-Tees, is to be officially opened by the Queen Mother on September 30. The bridge, which was built in sections on the Tees and shipped to Aberdeen for erection, is the first of its kind in Scotland.

ECONOMY is one of the reasons given for the slowing-down of the rate of stockpiling of strategic materials for arms production in the United States. Stockpiling of high priority items such as alloy metals will be completed by June, 1954, if possible, but for other items the completion date will be postponed to June, 1955, or beyond.

A NEW THREE-STOREY BUILDING has recently been completed at the works of Edgar Allen & Company, Limited, steelmakers, of Sheffield. The building houses mainly the equipment and personnel for chemical investigation, and includes an experimental machine shop or toolroom and sections for physical metallurgy and other research work.

(*Continued on page* 376)

WE REGRET that in an announcement of R. J. Richardson & Sons, Limited, in our issue of September 3, the address of Garringtons, Limited (Bromsgrove, Worcestershire) was incorrectly quoted.

A WHOLE-DAY SYMPOSIUM on cathodic protection will be held at the Institution of Electrical Engineers, London, W.C.2, on Friday, November 13, beginning at 9.45 a.m. Seven papers will be presented embodying experience gained in various parts of the world with the protection of ships, underground pipes, storage tanks and other structures used in contact with water or soil.

A CONTROLLING INTEREST has been purchased by Hills (West Bromwich), Limited, manufacturers and engineers to the building trades, in Bryan's Adamanta, Limited, Birmingham. This firm has acquired additional premises, and installed plant for the rapid production of precast plaster units, partitions, fireproof ceilings, etc., and its new managing director will be Mr. E. D. Hinchliffe, managing director of the parent company.

AS PREVIOUSLY ANNOUNCED the Bureau International de la Récupération (B.I.R.) is holding its next conference in London on September 24 and 25. The meetings are to be held at the Piccadilly Hotel, London, W.1, and there is to be a dinner-dance at the Dorchester Hotel, Park Lane, London, W.1. Meetings dealing with iron and steel scrap and non-ferrous scrap are to start at 9 a.m. on September 24. It is presumed the meetings are private.

BRITISH FIRMS are to have an opportunity of competing for the contract for the erection of a bridge across the River Ganges 50 miles east of Patna, India. The new project, which altogether will cost about £12,000,000, will open up the coal and iron resources of northern Bihar and will link two of India's important railway systems. The undertaking will include the construction of guide and protection works, a new transhipment yard, and ancillary works.

AS A RESULT of seeing an industrial film made at the works of F. H. Lloyd & Company, Limited, Wednesbury, and shown at a recent Düsseldorf exhibition, Mrs. Lissy Russ, owner of the Russ-Electroofen plant at Cologne has come to England to see the Lloyd works personally. Accompanied by her chief engineer, she visited the Wednesbury factory of September 8 and before her return to Germany is to see work done at the Burton-on-Trent and Derby premises of subsidiary companies.

CRAVEN BROS. (MANCHESTER), LIMITED, is just completing the largest machine tool ever built in Great Britain. This vertical boring and turning mill, which is now undergoing its final test, weighs 650 tons, and has a work turning table 41 ft. in dia., which will rotate at a maximum peripheral speed of 450 ft. per min. The machine is for export to Canada, where it will be used in the manufacture of the largest hydro-electric installation components, water-turbine parts, steam-turbine casings, etc.

TO RECAPTURE Scottish trade which has gone South, Switchgear & Equipment, Limited, Blantyre Industrial Estate, are negotiating an extension to their factory sufficient to double their present floor space and to treble production. At an exhibition of their products, Mr. D. D. W. Hope, a director of the firm, whose head office is in Banbury, explained that he was confident that more Scottish trade could be obtained if delivery dates were reduced. The new extension would necessitate doubling the number of employees.

W. & A. E. BREARLEY (MACHINERY) LIMITED, Station Works, Ecclesfield, Sheffield, have absorbed Aldam (Misterton) Limited, iron and non-ferrous founders, of Misterton, near Doncaster, and, except for certain repair and maintenance, the complete organisation will be transferred to Misterton. An associated company, W. Brearley & Company, Limited, wire manufacturers, will remain at Ecclesfield and correspondence should, from September 15, be addressed in the case of the parent company to Misterton and for the subsidiary concern to Ecclesfield.

BRITISH FIRMS received orders for oil equipment and materials valued at £38,000,000 during the first half of this year, according to figures issued by the Council of British Manufacturers of Petroleum Equipment. Orders received during the second quarter of 1953 were valued at £16,466,100. The most important items in this total were bulk chemicals which amounted to £2,757,700, tubulars, pipefittings and valves (£1,972,200), drilling and production equipment (£1,714,800), and refinery equipment (£1,711,200). Other leading groups were machine and hand tools, etc., and electrical equipment, each of which received orders valued at over £1,000,000.

AT THE ENGINEERING AND MARINE EXHIBITION at Olympia, which closes to-day, for the first time in this country and possibly for the first time in any country, Shell-Mex and B.P. Limited publicly demonstrated the use of radio-active isotopes for the investigation of engine wear. The unit used for the demonstration was a single-cylinder compression-ignition engine fitted with a piston-ring irradiated in the atomic pile at Harwell. With such equipment, extremely-accurate wear measurement is possible and one-millionth of an ounce of metal can be detected. Actual engine wear is electronically calculated and the result is transmitted to a continuous recording graph while the engine is running.

ADDRESSING a convention of the Institution of Production Engineers at Birmingham University on September 5, Sir Cecil Weir, the industrialist and former chairman of the Dollar Exports Board, now head of the United Kingdom delegation to the High Authority of the European Coal and Steel Community, said that human relations were the most important factor in industry, and the key to successful production. He suggested that human relations were very much the concern of the production engineer, whose job it was to introduce new ideas and new methods, some of which would rouse antagonism in operators, to whom all new projects should be explained. The conference was also addressed by Mr. Ian Morrow, deputy managing director of the Brush group of companies.

AN ADVANCED DIPLOMA COURSE in industrial engineering is to be organized during the coming session at Wolverhampton and Staffordshire Technical College. Designed for students chosen as potential future executives, it is planned to meet the need in industry for highly-qualified production engineers. Mr. C. L. Old, principal of the college, believes that such a course is unique in the Midlands. During the three years of the course, students will each year spend six months in full-time study at college and six months gaining works experience. The students will cover the complete requirements of the associate membership examinations of the Institution of Mechanical Engineers and the Institution of Production Engineers, as well as the City and Guilds full technological certificate in machine-shop engineering and mechanical-engineering inspection.

Interesting Exhibits.—In the paragraph on page 312 of last week's issue dealing with tests on spheroidal graphite cast iron at the Engineering and Marine Exhibition, it was stated that the S.-g. iron ring opened under test to a greater degree than the ordinary iron. Actually, the reverse was the case—the S.-g. iron revealing the greater modulus of elasticity. Apologies are tendered to all readers who may have been confused.

Raw Material Markets

Iron and Steel

Supply and consumption of pig-iron have been brought into approximate equilibrium. Well supplied with raw materials, the blast furnaces are regularly meeting their commitments and there are no serious deficiencies in the output of the various grades of pig-iron. Specifications for refined iron have not been coming forward quite so freely of late and small supplies of No. 3 foundry iron are occasionally taken into stock, but consumption of other grades is on a rising scale and a further expansion of output is envisaged in the near future.

Supplies of home-produced billets, blooms, slabs, and sheet bars are now being distributed in greater abundance than has been the case for several years past and, as the re-rolling mills are running below capacity, there has been a sharp contraction in the tonnages of imported material. The greater abundance of primes has also had the effect of limiting buyers' interest in defectives, crops, and certain classes of re-rolling scrap.

Relaxation of the pressure for deliveries of various descriptions of rolled steel products is not wholly unwelcome. It has enabled the mills to overtake some of the arrears and the ability of the makers to accept fresh business with shorter delivery dates should prove advantageous to consumers and producers alike. Plates are perpetually in short supply and order-books for joists, sections, rails, etc., are still in a healthy condition. British export prices are keenly competitive and an increase of oversea inquiries suggests that a modification of import restrictions in Australia, Argentina, and Finland would lead to an expansion of the oversea trade.

Non-ferrous Metals

The July figures of the British Bureau of Non-ferrous Metals show *inter alia* that no improvement has taken place in copper. Consumption dropped from 32,366 tons in June to 30,873 tons in July, and of this less than 15,000 tons comprised virgin copper. Stocks at just under 200,000 tons were up by about 14,000 tons, the Government's holding being 187,500 tons, while it had also afloat and abroad about 46,000 tons. Compared with the first seven months of 1952, when the usage of copper was about 216,000 tons, the corresponding figure this year is 128,000 tons, a very poor showing which the remainder of the year is hardly likely to put right. Our usage of zinc in July, virgin, remelted, and scrap amounted to 19,226 tons, compared with 21,141 tons in June. Stocks of virgin zinc at July 31 were 34,609 tons, against 31,661 tons at June 30. Lead stocks stood at 25,820 tons, which showed a drop of about 1,000 tons on June 30, while consumption of virgin, remelted, and scrap in July was 23,455 tons, compared with 23,612 tons in June. Tin consumption was 1,328 tons, a drop of nearly 200 tons on the June figure of 1,519 tons, while stocks increased by 238 tons to 3,749 tons.

Last week was not a good one for bulls of the non-ferrous metals, although copper must be excepted from this statement. Influenced perhaps to some extent by the disastrous declines in share values on Wall Street, the trend of prices was mostly downwards, zinc showing itself to be particularly vulnerable to adverse influences. Two reductions in the price of this metal were seen in America, each of ½ cent, which brought the current level there down to 10 cents, equal to about £80. In London the break in values was severe, and the quotation touched the lowest seen for three months or more. The turnover was probably rather above average. Whether lead influenced zinc or the other way round it is hard to say, but the former, although closing virtually without change compared with a week earlier, was, nevertheless, below the best. Tin, too, lost ground. Copper, on the other hand, put up a good show.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* September 10, £230 to £232 10s.; September 11, £227 10s. to £232 10s.; September 14, £229 to £230; September 15, £227 10s. to £232 10s.; September 16, £230 to £235.

Three Months: September 10, £213 10s. to £214 10s.; September 11, £214 to £215; September 14, £213 10s. to £214; September 15, £213 to £213 10s.; September 16, £215 10s. to £216.

TIN, Standard—*Cash:* September 10, £610 to £612 10s.; September 11, £607 10s. to £608; September 14, £607 10s. to £608; September 15, £597 10s. to £600; September 16, £597 10s. to £600.

Three Months: September 10, £605 to £607 10s.; September 11, £601 to £602; September 14, £600 to £602; September 15, £595 to £597 10s.; September 16, £589 to £590.

ZINC—*September:* September 10, £70 2s. 6d. to £70 7s. 6d.; September 11, £69 to £69 10s.; September 14, £67 12s. to £67 15s.; September 15, £67 5s. to £67 7s. 6d.; September 16, £67 10s. to £67 12s. 6d.

December: September 10, £70 to £70 2s. 6d.; September 11, £69 to £69 10s.; September 14, £67 10s. to £67 15s.; September 15, £67 2s. 6d. to £67 7s. 6d.; September 16, £67 2s. 6d. to £67 5s.

LEAD—*September:* September 10, £95 15s. to £96; September 11, £94 10s. to £94 15s.; September 14, £92 15s. to £93; September 15, £91 to £91 10s.; September 16, £90 10s. to £91.

December: September 10, £91 10s. to £91 15s.; September 11, £90 to £90 5s.; September 14, £89 to £89 10s.; September 15, £87 5s. to £87 15s.; September 16, £87 5s. to £87 10s.

Swedish Iron and Steel

The Swedish Government started pig-iron production at the Norrbottens Järnverk, Lulea (just south of the Arctic Circle), in 1943 and has since developed the works into an integrated plant, although it is still not completed. Reports indicate that the plant is running into financial difficulties.

Heavy losses are expected this year, according to statements by the board. The company has a relatively small capital and has had to resort to large credits from the State and the banks. A reduction of pig-iron output appears to be inevitable.

Erection of the works was criticized by the privately owned iron and steel industry of Central Sweden and also was attacked by political parties. The management maintains that the technical and economic bases of the plant are sound and that it will eventually pay its way.

Sweden/U.S.S.R. Trade Agreement

Under a trade agreement signed between Sweden and Russia, Sweden will export 600 metric tons of unalloyed steel, 100 tons of high-speed steel, 100 tons of stainless steel, 1,000 tons of drill steel, 300 tons of cold-rolled hoop, 500 tons of cold-drawn steel wire, 800 tons of ball-bearing tube, and about £1,000,000 worth of drilling machinery and parts. Russia will export 60,000 metric tons of chrome ore, 15,000 tons of manganese ore, and 300 tons of manganese.

Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

September 16, 1953

PIG-IRON

Foundry Iron.—No. 3 Iron, Class 2:—Middlesbrough, £13 18s.; Birmingham, £13 11s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £16 14s. 6d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £17 0s. 3d.

Scotch Iron.—No. 3 foundry, £16 11s., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £18 3s.; South Zone, £18 5s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £19 3s.; South Zone, £19 5s. 6d.

Hematite.—Si up to 2½ per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. Coast and N.-W. Coast of England, £16 12s.; Scotland (Scotch iron), £16 18s. 6d.; Sheffield, £17 13s.; Birmingham, £17 19s. 6d.; Wales (Welsh iron), £16 18s. 6d.

Basic Pig-iron.—£14 6s. 6d. all districts

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered).

Ferro-silicon (6-ton lots).—40/55 per cent., £53 10s., basis 45 per cent. Si, scale 21s. 6d. per unit; 70/84 per cent., £82 10s., basis 75 per cent. Si, scale 23s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 10s. to 11s. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £165 to £181 per ton; 38/40 per cent., £229 to £235 per ton.

Ferro-tungsten.—80/85 per cent., 21s. 4d. to 22s. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 24s. 3d. to 26s. 6d. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent. C, £85 4s., basis 60 per cent. Cr, scale 28s. 3d. per unit: 6/8 per cent. C, £80 17s., basis 60 per cent. Cr, scale 26s. 9d. per unit; max. 2 per cent.C, 2s.2d. per lb. Cr; max. 1 per cent. C, 2s. 2½d. per lb. Cr; max. 0.15 per cent. C, 2s. 3½d. per lb. Cr; max. 0.10 per cent. C, 2s. 3¾d. per lb. Cr; max. 0.06 per cent. C, 2s. 4d. per lb. Cr.

Cobalt.—98/99 per cent., 20s. per lb.

Metallic Chromium.—98/99 per cent., 6s. 3d. to 6s. 9d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £225 to £232 per ton; 96/98 per cent., £255 to £262 per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 40s. to 70s. per lb., Nb + Ta.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—Basic: Soft, u.t., £25 12s. 6d.; tested, 0.08 to 0.25 per cent. C (100-ton lots), £26 2s. 6d.; hard (0.42 to 0.60 per cent. C), £28; silico-manganese, £33 16s. free-cutting, £28 16s. 6d. Siemens Martin Acid: Up to 0.25 per cent. C, £32 12s.; case-hardening, £33; silico-manganese, £34 17s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic soft up to 0.25 per cent. C, £29 16s.; basic, hard, over 0.41 up to 0.60 per cent. C, £30 16s.; acid, up to 0.25 per cent. C, £33.

Sheet and Tinplate Bars.—£25 11s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £30 6s. 6d.; boiler plates (N.-E. Coast), £31 14s.; floor plates (N.-E. Coast), £31 15s. 6d.; heavy joists, sections, and bars (angle basis), N.-E. Coast, £28 9s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £32 4s. 6d.; flats, 5 in. wide and under, £32 4s. 6d.; hoop and strip, £32 19s. 6d.; black sheets, 17/20 g., £41 6s.; galvanized corrugated sheets, 24 g., £49 19s. 6d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £51 14s. 3d.; nickel-chrome, £73 3s. 6d.; nickel-chrome-molybdenum, £80 18s. 3d.

Tinplates.—57s. 9d. per basis box.

NON-FERROUS METALS

Copper.—Cash, £230 to £235; three months, £215 10s. to £216; settlement, £235.

Tin.—Cash, £597 10s. to £600; three months. £589 to £590; settlement, £597 10s.

Zinc.—September, £67 10s. to £67 12s. 6d.; December, £67 2s. 6d. to £67 5s.

Refined Pig-lead.—September, £90 10s. to £91; December, £87 5s. to £87 10s.

Zinc Sheets etc.—Sheets, 15 g. and thicker, all English destinations, £95 17s. 6d.; rolled zinc (boiler plates), all English destinations, £93 12s. 6d.; zinc oxide (Red Seal), d/d buyers premises, £87.

Other Metals.—Aluminium, ingots, £150; magnesium, ingots, 2s. 10½d. per lb.; antimony, English, 99 per cent., £225; quicksilver, ex warehouse, £64 15s.; nickel, £483.

Brass.—Solid-drawn tubes, 22d. per lb.; rods, drawn, 31⅞d.; sheets to 10 w.g., 246s. 3d. per owt.; wire, 29⅞d.; rolled metal, 233s. per owt.

Copper Tubes, etc.—Solid-drawn tubes, 27¼d. per lb.; wire, 261s. 6d. per cwt. basis; 20 s.w.g., 290s. 6d. per owt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £160 to £170; BS. 1400—LG3—1 (86/7/5/2), £170 to £190; BS. 1400—G1—1 (88/10/2), £252 to £285; Admiralty GM (88/10/2), virgin quality, £252 to £300 per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £265 to £295; L.P.Bl, £215 to £240 per ton.

Phosphor Bronze.—Strip, 347s. per owt.; sheets to 10 w.g., 368s. 9d. per cwt.; wire, 43⅞d. per lb.; rods, 38½d.; tubes, 36½d.; chill cast bars: solids 38d., cored 39d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Rolled metal, 3in. to 9in. wide × .056, 3s. 0½d per lb.; round wire, 10g., in coils (10 per cent.), 3s. 5½d.; special quality turning rod, 10 per cent., ½in. dia., in straight lengths, 3s. 4½d. All prices are net.

Forthcoming Events

SEPTEMBER 18

Institute of British Foundrymen

East Midlands branch (Northampton and district):—" Foundry Sand Control," by A. Tipper, M.Sc., 7.30 p.m., at Northampton. Details from the branch secretary.

SEPTEMBER 19

West Riding of Yorkshire branch:—Presidential address by C. S. Johnson, 6.30 p.m., at the Technical College, Bradford, preceded by tea at 1, Mannville Terrace (opposite the Technical College), at 4.45 p.m.

SEPTEMBER 21

Incorporated Plant Engineers

Merseyside and North Wales branch:—" Paint in Industry," by P. I. Gay, B.Sc., 7.15 p.m., at Radiant House, Bold Street, Liverpool.

Institution of Production Engineers

Derby section:—Presidential address by W. C. Puckey, M.I.Prod.E., F.I.I.A., 7 p.m., at the Midland Hotel, Midland Road.

SEPTEMBER 22

Manchester graduate section:—" Die-casting," by T. Bradshaw, 7.15 p.m., Room C3, Reynolds Hall, College of Technology.

Institution of Works Managers

Merseyside branch:—Annual General Meeting, Reece's Restaurant, Liverpool.

Wolverhampton branch:—" Is there too much talk about Management? " by D. G. Petrie, 7 p.m., at the Star and Garter Royal Hotel.

SEPTEMBER 23

Paisley group:—Informal Discussion, 7.30 p.m., in the canteen of Eadie Brothers & Company, Limited.

SEPTEMBER 24

Incorporated Plant Engineers

Sheffield and District branch:—" Electrical Factory Regulations," 7.30 p.m., at the Grand Hotel.

Institute of British Foundrymen

Southampton section:—" Casting Defects," by J. L. Francis, 7 p.m., in the Southampton Technical College, St. Mary Street.

SEPTEMBER 26-27

8th Annual Golf Meeting at Woodhall Spa.

SEPTEMBER 26

East Midlands branch:—Presidential Address by H. Pinchin, and two films, " Mechanization of Moulding " and " Modern Malleable," 6 p.m., at the College of Arts, Derby.

Lower Western German Steel Tariffs

From September 1, Western Germany has reduced tariffs against the imports of iron and steel products from non-member countries of the European Coal and Steel Community. The new tariff of 6 per cent. to 8 per cent. instead of the former 14 per cent. to 18 per cent. is in force for one year. It is emphasized in Bonn that this lower tariff is only applicable to a monthly import quota of 120,000 metric tons, of which 50,000 tons will be plate and strip, and that this quota has been fixed to allay French fears that Germany will re-export this steel to other pool countries.

French fears have not, however, been allayed. The French point out that last year Germany imported a total of 836,000 metric tons, of which 792,000 tons came from pool countries, the annual amount imported from non-pool countries being 44,000 metric tons. As the new quotas would allow an import of 1,440,000 metric tons a year from non-pool countries, or 30 times the amount actually imported from these sources, it is not surprising that the French are apprehensive.

(continued in next column)

PROPERTY—*contd.*

Lot 4.
THE FREEHOLD AGRICULTURAL LAND,
With a frontage of about 500 ft., to the COMPTON-ILSLEY ROAD,
and containing an area of approx. 4 Acres.

Note.—THE MODERN FOUNDRY PLANT, MACHINE TOOLS and EQUIPMENT will be offered for Sale by Auction, in Lots, immediately following the offering of the Properties, but the Auctioneers are prepared to entertain offers for the WORKS AS EQUIPPED, any time up to within 7 days of the advertised date of the Auction.

Particulars and Conditions of Sale of the Properties (price 6d. each) may be obtained of: Messrs. SIMMONS & SIMMONS, 1, Threadneedle Street, London, E.C.2, and of Messrs. HENRY BUTCHER & CO., Auctioneers, Valuers & Surveyors of Factories, Plant and Equipment, 73, Chancery Lane, London, W.C.2.
Telephone: HOLborn 8411 (8 lines).

By order of the Receiver.
Re: T. Baker & Son (Foundry and Engineers), Ltd.

WHITEWALL IRONWORKS, COMPTON, BERKS.

HENRY BUTCHER & CO.
are instructed to offer for SALE BY AUCTION, at the Works on
WEDNESDAY, 14th OCTOBER, 1953,
at 11 a.m., as a first Lot, the
GOODWILL OF THE BUSINESS OF MESSRS. T. BAKER & SON (FOUNDRY & ENGINEERS), LTD.,
including any data, patterns or drawings for the manufacture of Baker Loaders, Water and Tumbler Cars, Road Sweepers, Municipal Vehicles.
To be followed by the SALE in Lots, in Detail, of the

MODERN FOUNDRY PLANT, MACHINE TOOLS AND EQUIPMENT.

including
"Foundry Equipment Co." Sand Handling Plant; "Jackman" Sand Shaker; "Linslade" Automatic Sand Rammer; "Green" 1½- and 4-cwt. Cupolas; "Foundry Equipment" Jolt Moulding Machine; Overhead Electric Cranes and Hoists; Sand Mills; Steel Hoppers; Disintegrators; Magnets; Belt and Bucket Elevators; Iron and Steel Moulding Boxes; Ladles; Foundry Weights; Graphite Pots; Trolleys and Trucks; S.S. and S.C. Capstan and Turret Lathes; "Lapointe" Broaching Machine; Horizontal Borers; Radial and Pillar Drilling Machines; Slotting and Grinding Machines; Vertical and Horizontal Milling Machines; Sheet Metal and Woodworking Plant; Arc Welding Sets; Air Compressors, Profile Cutters, Cold Saws; Consumable Stores and Stock of Steel; Motor Vehicles; Engineers' Small Tools; Office Furniture and Equipment.

Note.—THE FREEHOLD FACTORY, FOUNDRY and HOUSES will be offered for Sale in Lots immediately prior to the PLANT and EQUIPMENT, and the Auctioneers are prepared to entertain offers for the FREEHOLD WORKS as equipped any time up to within 7 days of the advertised date of the Auction.

Catalogue of the Plant and Machinery (price 6d. each) may be obtained of: Messrs. JOSOLYNE, MILES & CO., Chartered Accountants, 28, King Street, Cheapside, London, E.C.2.; of Messrs. WILD, COLLINS & CROSSE, Solicitors, 87, Duke Street, Grosvenor Square, London, W.1; and of
Messrs. HENRY BUTCHER & CO.,
Auctioneers, Valuers and Surveyors of Factories, Plant and Equipment, 73, Chancery Lane, London, W.C.2.
Telephone: HOLBorn 8411 (8 lines).

PROPERTY—*contd.*

FOR SALE, as a Going-Concern, Non-ferrous Repetition and Jobbing Foundry with Machine-shop and Pattern-shop, situated in Scottish east coast town. The buildings and plant are modern. Floor area approximately 9,500 sq. ft. with ground available for extension. Further particulars to genuine enquirers apply Box 437, ROBERTSON & SCOTT, 42, Charlotte Square, Edinburgh, 2.

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QUOTATIONS required for C.I. Castings (Boiler Doors). Those interested in Tendering, write Box 3763, FOUNDRY TRADE JOURNAL.

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ONE Copy of "Melting Iron in the Cupola" by J. E. Hurst. Please write Box 3756, FOUNDRY TRADE JOURNAL.

WANTED.—2 tons, or thereabouts, Electric Arc Steel Melting Furnace. Age not important. Hand-operated electrodes accepted.—Box 3733, FOUNDRY TRADE JOURNAL.

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Pallett Conveyor, plates about 3 ft. by 2 ft.
Pneumatic Plain Jolter, table 21 in. by 17 in.
Rotary Blower, 1,400 c.f.m. to 7 lbs. per sq. in. pressure.
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Sand Mills, up to 6 ft. dia. pan.
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2 pairs of Pagets Boxes. 16 in. by 14 in. by 4 in. by 4 in.
2 pairs of Pagets Boxes. 16 in. by 14 in. by 4½ in. by 4 in.
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3 pairs of Pagets Boxes. 9 in. by 7 in. by 3 in. by 4 in.
1 pair of Pagets Boxes. 12 in. by 12 in. by 4 in. by 4 in.
½ box of Pagets Boxes. 12 in. by 12 in. by 5 in. by 4 in.
1 pair of Pagets Boxes. 12 in. by 12 in. by 4 in. by 4 in.
1 pair of Pagets Boxes. 24 in. by 14 in. by 8 in. by 4 in.
½ box for above. 24 in. by 14 in. by 8 in. by 4 in.
1 pair of Pagets Boxes. 28 in. by 18 in. by 3½ in. by 4 in.
2 pairs of Pagets Boxes. 28 in. by 18 in. by 4 in. by 4 in.
4½ pairs Stirling Boxes. 20 in. by 15 in. by 4 in. by 4 in.
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4 pairs Wooden Boxes. 24 in. by 18 in. by 6 in. by 4 in.
6 pairs Wooden Boxes. 12 in. by 12 in. by 4 in. by 4 in.

W. J. HOOKER, LTD.,
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MACHINERY FOR SALE—*contd.*

FOR SALE: HUNDTWEBER CENTRIFUGAL CASTING MACHINE suitable for casting Bronze Bushing, Cylinder Liners, Piston Rings, etc. Condition as new.—Box 3750, FOUNDRY TRADE JOURNAL.

SECONDHAND Ajax Plain Jolter, No. 16 size, 5 ft. 5 in. sq. table. 180 jolts per minute at 80 lbs. per sq. in. Air Pressure. Good condition, new machine in November, 1947. Costing £658; price required £50, f.o.r. Sunderland.—R. W. COLLIN, LTD., Pallion Foundry, Sunderland. Telephone: Sunderland 4987.

HERMAN JARR ROLLOVER MACHINE with clamps, size 25 in. by 36 in., 750 lbs. capacity. Ten years old, but not used in high production unit. £335.—RICHARDS, Phoenix Works, Leicester.

FOR SALE: 7 ft. 6 in. Edge Runner Grinding Mill by Smedley Brothers, Belper. Serial No. 8145. Over-geared Drive. G.E.C. Starter and 25 h.p. Motor. For further information contact Works Engineering Dept., K. & L. STEELFOUNDERS & ENGINEERS LTD., Letchworth, Hertfordshire.

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CAPACITY AVAILABLE—*contd.*

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MISCELLANEOUS

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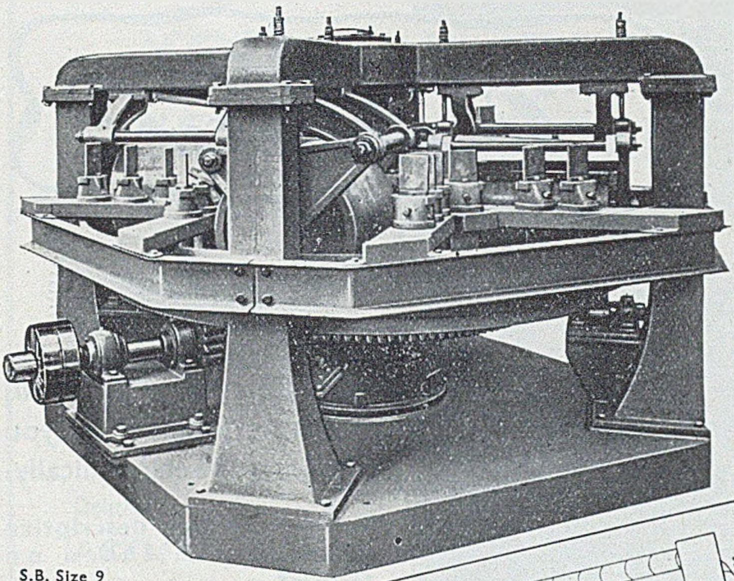

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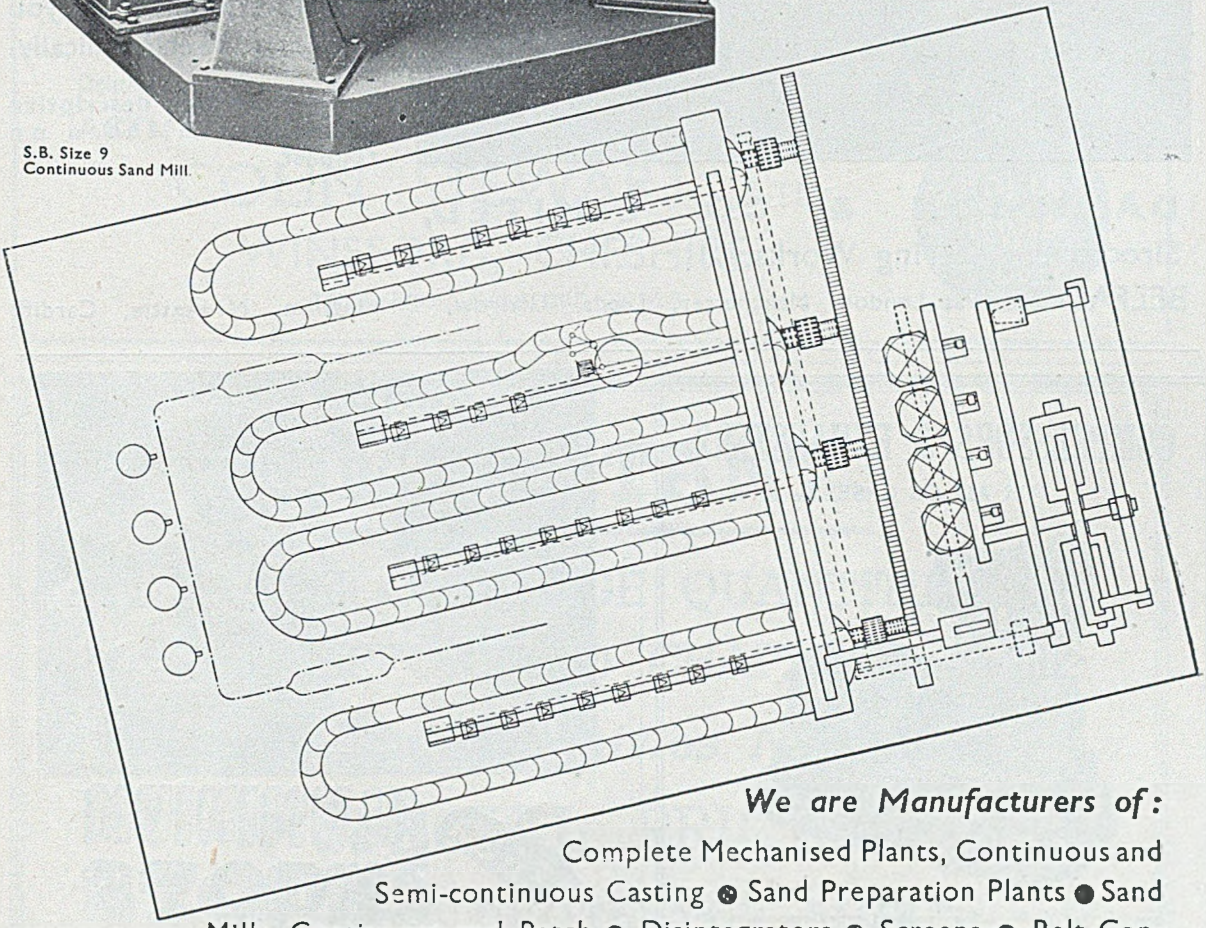

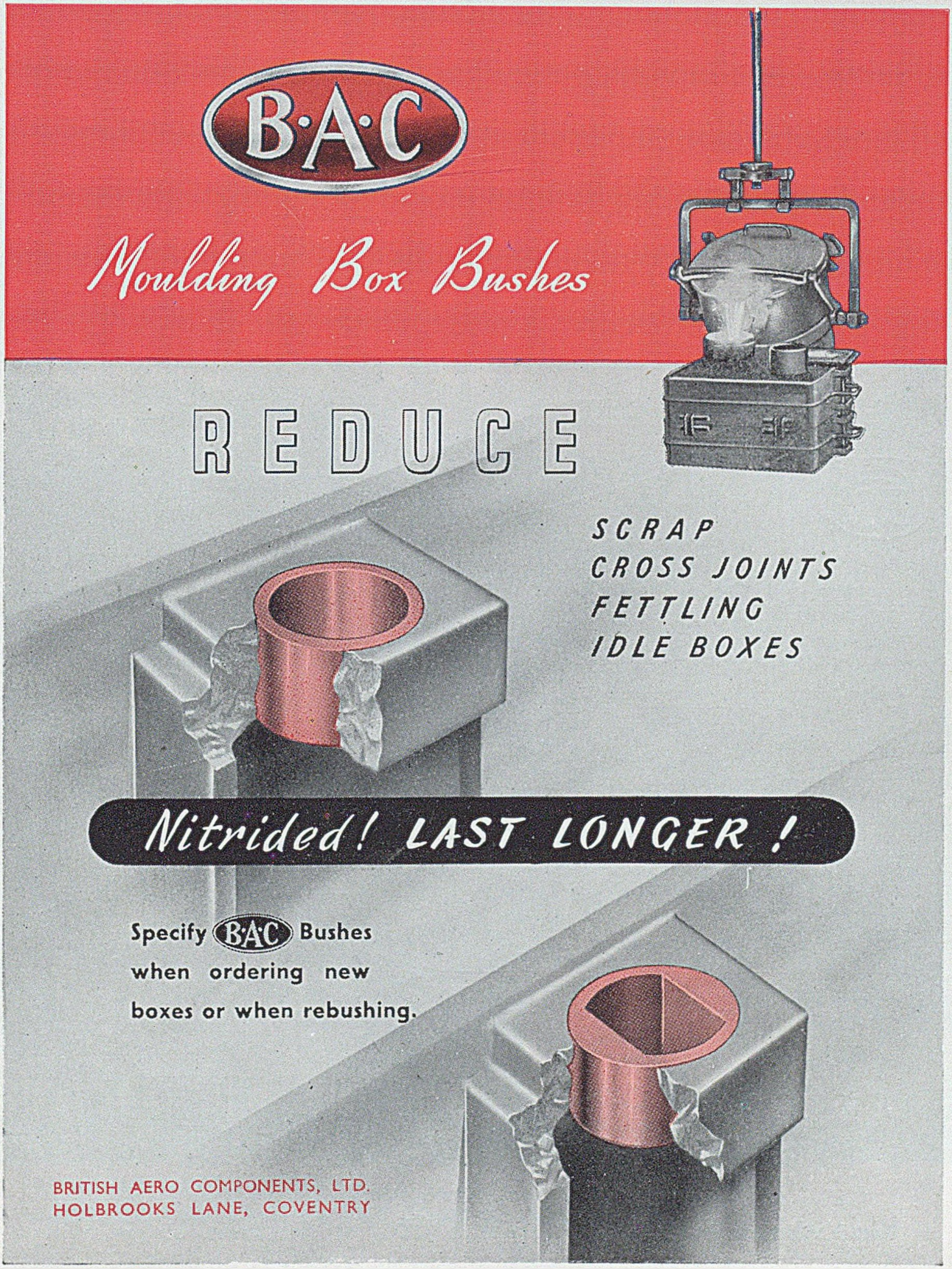
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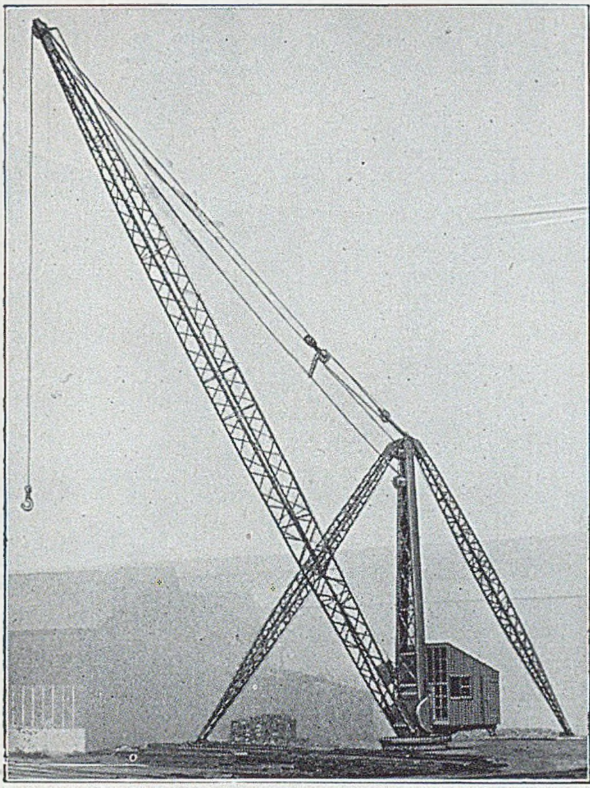

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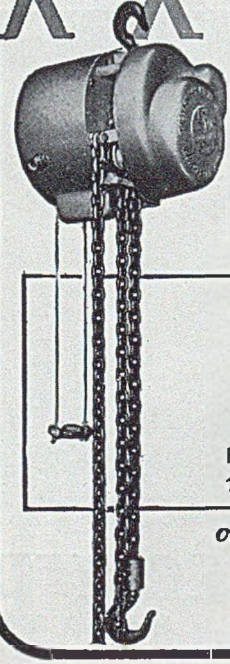

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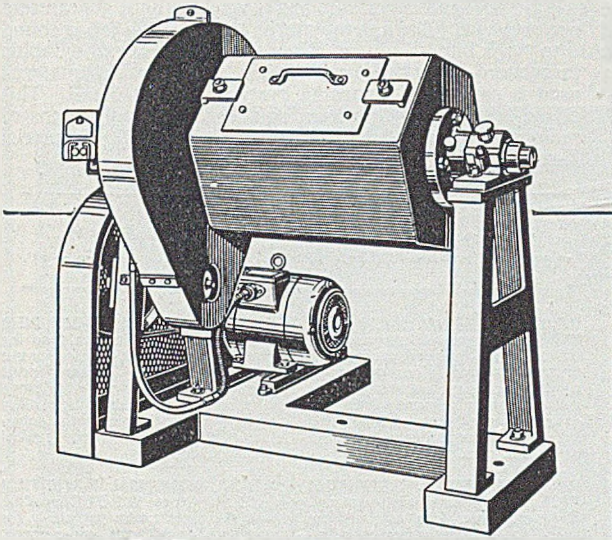

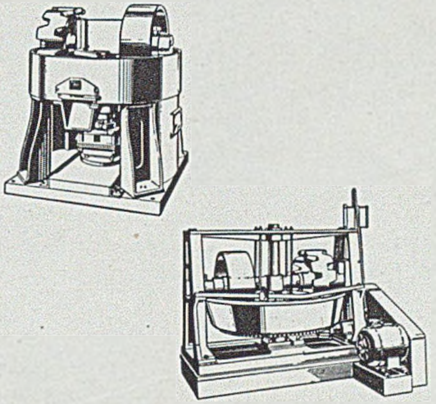

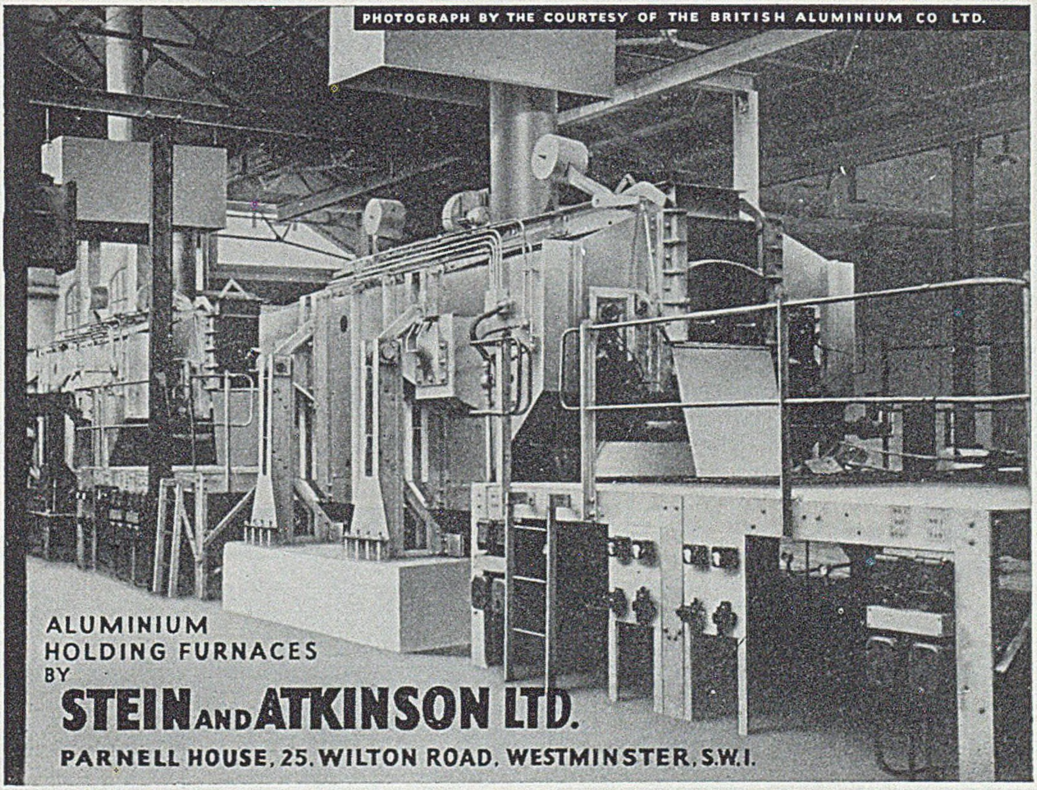
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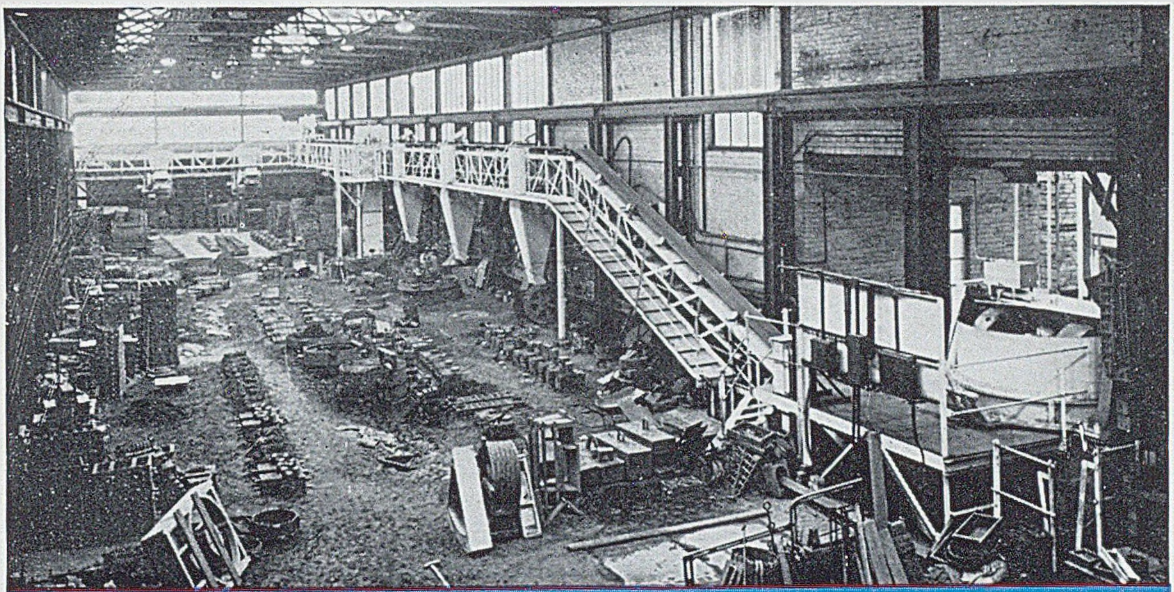

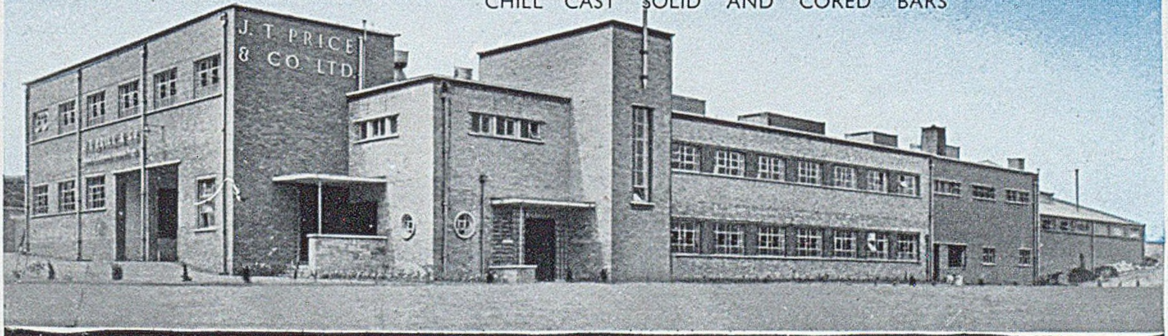
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