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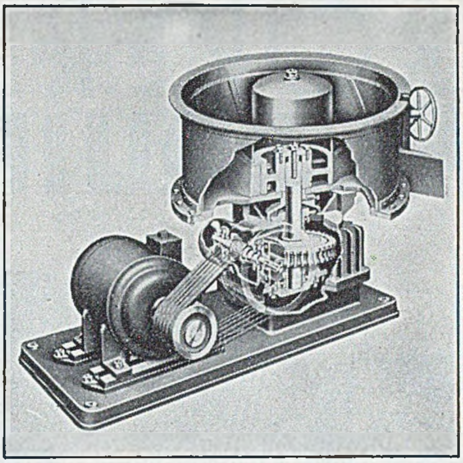

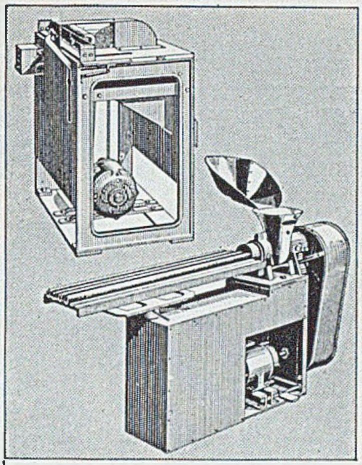

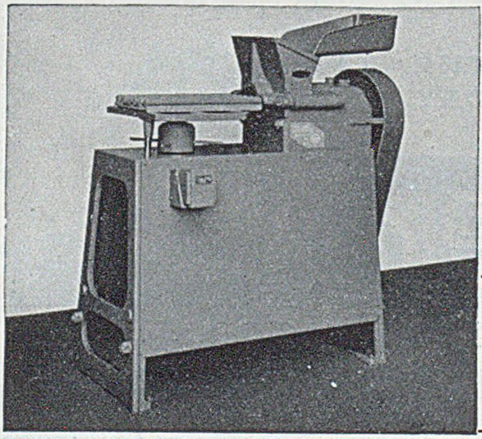

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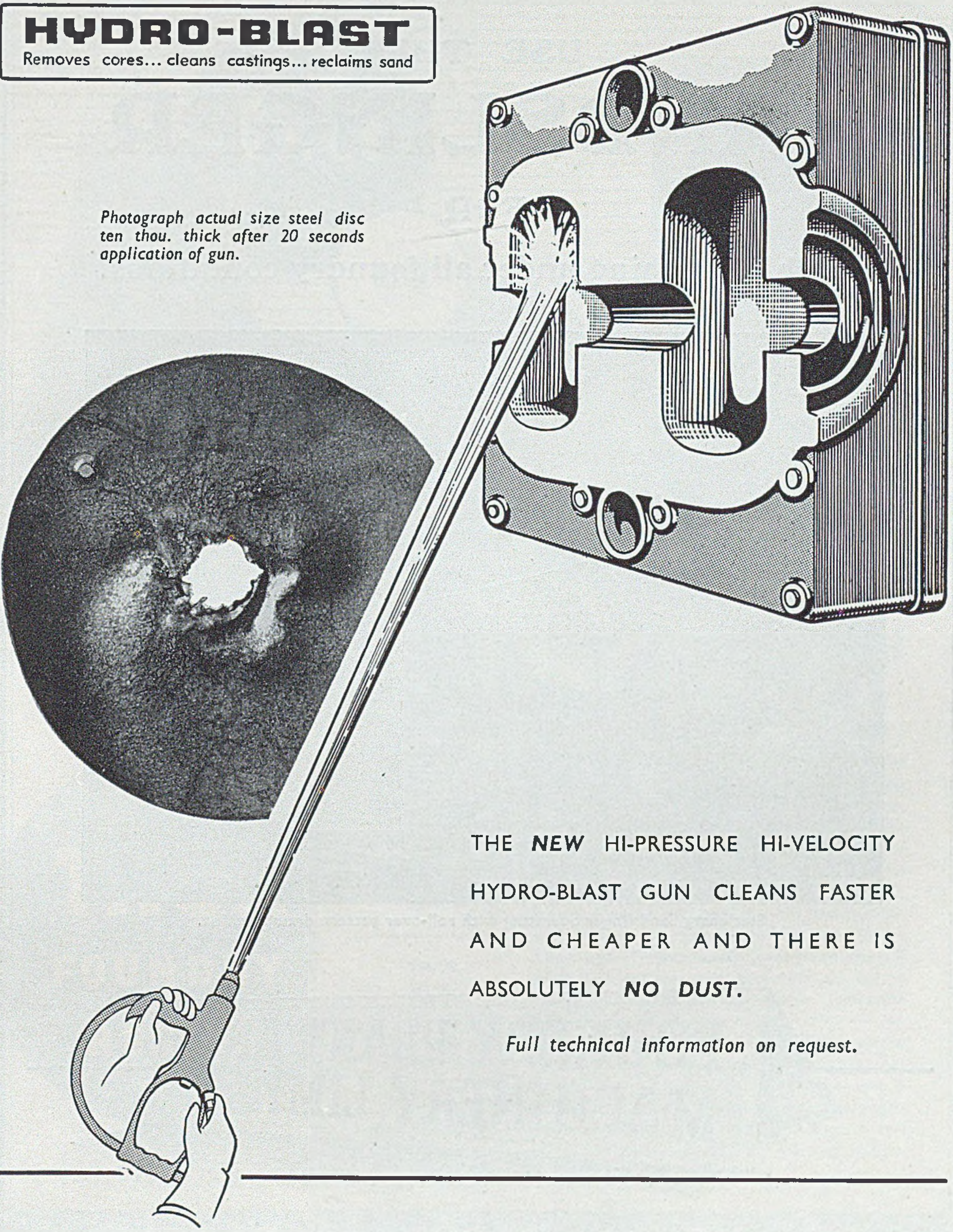

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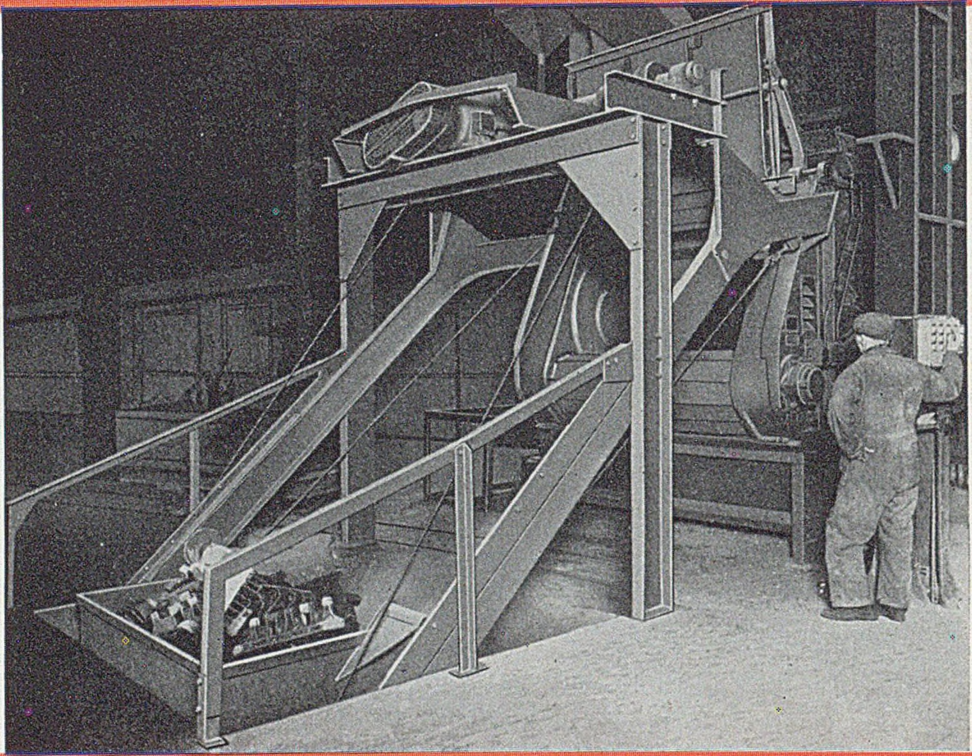

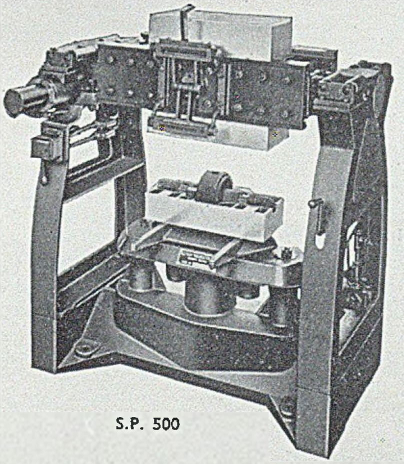

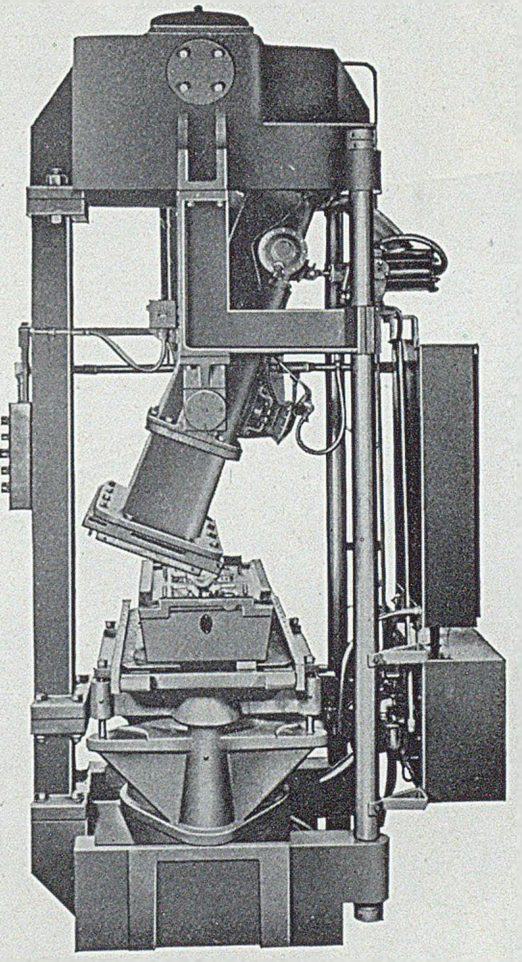

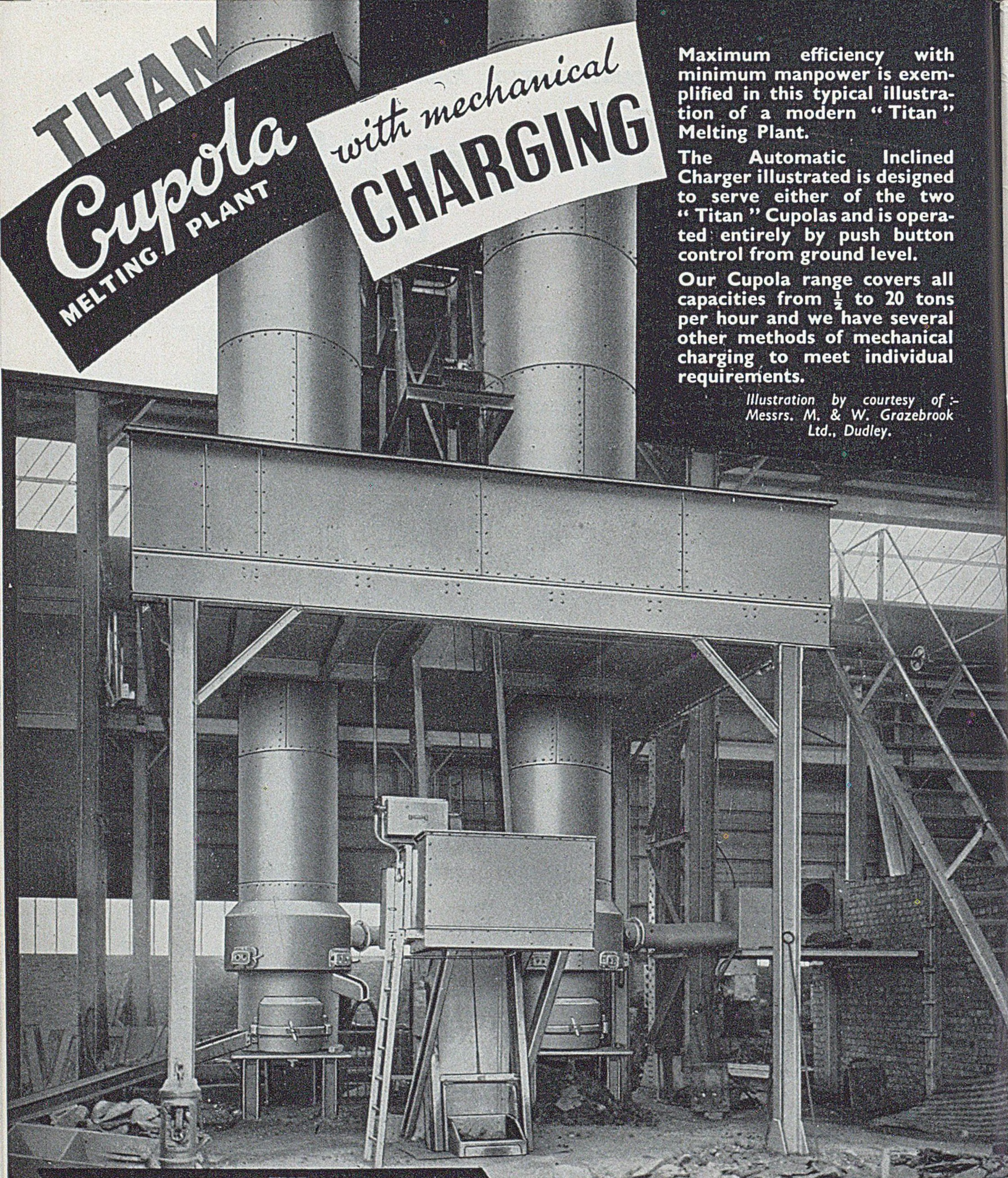

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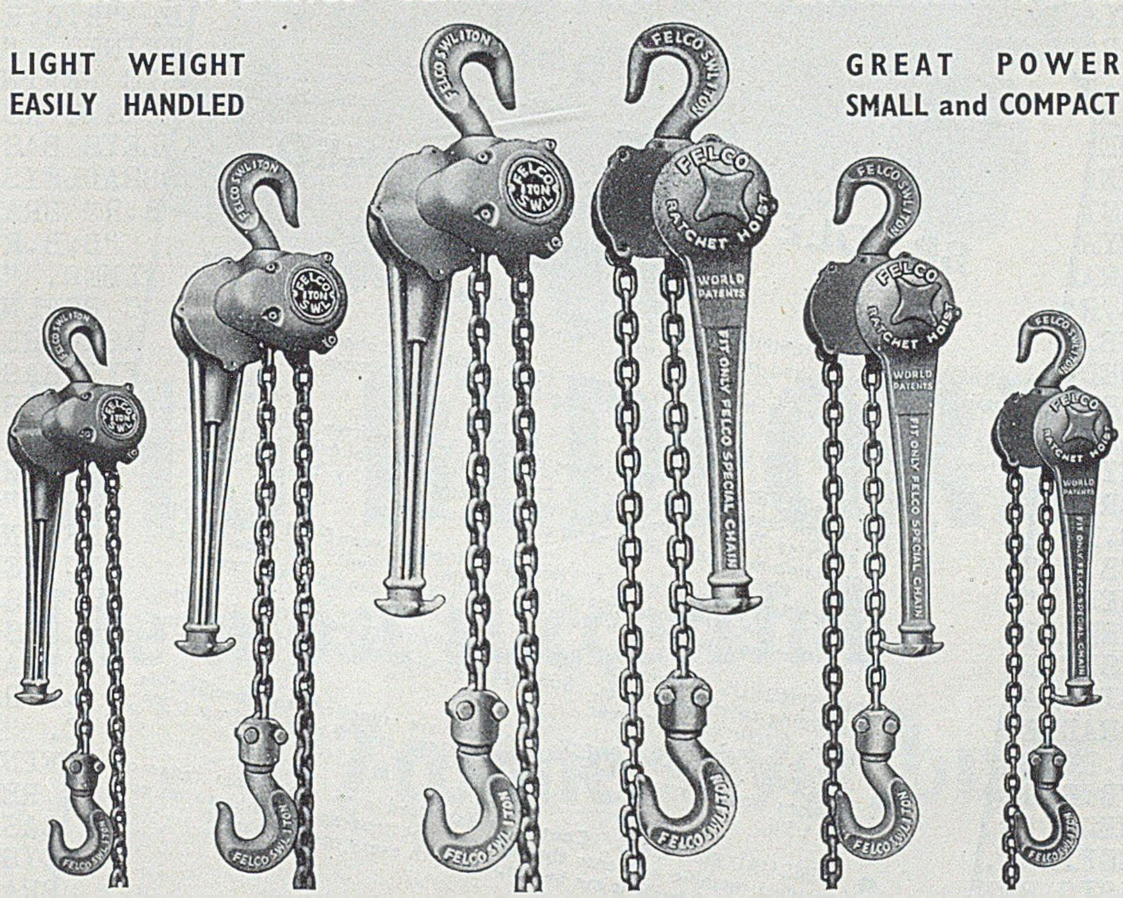

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Field for Spheroidal-graphite Iron

At the Paris International Congress which opened last Saturday, something of the order of sixty technical papers are being presented and of these no fewer than six deal with spheroidal-graphite cast iron. They emanate from three countries, America, France and Great Britain and their study enables one to obtain a clear picture of the progress realized and future prospects. Rightly, there is an effort to detract interested opinion from the mere recital of much-higher-tensile properties and to direct attention to many industrial applications. Amongst these is the shock-resistance property and in this connection there are two papers from the Birmingham area—one by Mr. G. N. J. Gilbert of the British Cast Iron Research Association and another by Mr. A. L. Carr and Dr. W. Steven of the Mond Nickel Company's laboratories. This laboratory, through Mr. R. M. Lamb, provides the third English paper on this subject and covers the influence of copper on spheroidal-graphite cast iron containing magnesium, which, put very shortly, shows that copper is by no means efficient for introducing magnesium into cast iron. The two papers on the subject from France are by Dr. M. Ballay, prepared in one case in collaboration with Mr. J. Grilliat, and in the other together with a third author, Mr. R. Chavy. The subject of the former covers specifications and tests and the latter heat-treatment. The final paper of the half-dozen, American in origin, and written by Mr. Donald J. Reese, covers the present position and the future prospects and carries the subject of the application of spheroidal-graphite cast iron somewhat further than previous works. He likes the notion of using this material for motor-car crankshafts, because the finished component only weighs 3 to 4 per cent. less than the fettled weight of the casting, whilst for a 4½-ton shaft (as tooled), a casting though of the same dimensions, weighs 800 lb. less. Reese cites the potentialities of this material for pipe-lines—when centrifugally cast, the price should be satisfactory, and there only remains to be solved the problem of welding. This operation, according to a personal source of information, is only difficult *in situ*, as claims are made to have satisfactorily welded the material experimentally. Should this come about, the prospects for S.-g. cast-iron pipe are indeed rosy. Next, this author deals with steelworks rolls, and here he claims lowered wear; better surface finish on the rolled product, associated with a higher output thereof. The property of this material found most difficult to control is—according to the long experience of Reese—that of hardness. Finally, he describes and illustrates an aviation component—a ring support—which has replaced forged aluminium.

For making S.-g. cast iron, the founder must be as alive to the technique of running and risering as are the steel and malleable-iron manufacturers. The use of the basic cupola reveals distinct advantages, amongst which are the better running properties of the metal. The efforts of those interested in popularizing this relatively new material and so widening the scope of the foundry industry, are now being directed towards publicising to the engineer, not so much its tensile properties, but the hundred and one other factors, which go to stress its industrial usefulness.

Conference Paper Author

DR. W. T. PELL-WALPOLE, the Author of the paper "Effect of Pouring Conditions on Shrinkage Unsoundness in Bronze Ingots Cast in Metal, Carbon or Sand Moulds," printed on the adjoining pages, is a Research Fellow at the Metallurgy Department of Birmingham University. He was educated at Dudley Grammar School, Wednesbury County Technical College, and the University of Birmingham. From 1936 to 1939, he was a research investigator at Birmingham University for the Tin Research Institute and for the next three years was in this organization's service at Greenford in the capacity of senior metallurgist. In 1942, he became the Tin Research Institute's chief metallurgist and conducted research at Birmingham University in connection with foundry problems at various foundries. Since 1947, he has been engaged as a Research Fellow at Birmingham University, investigating the sand casting of copper alloys and continuous casting. He is a member of the Institute of Metals and of the Institution of Metallurgists.

Papers for 1954 I.B.F. Conference

The Institute of British Foundrymen is prepared to receive offers of papers for presentation at the 51st annual conference to be held at Glasgow in June, 1954. Manuscripts will be required not later than December 31. The Council wishes to emphasize that it will be particularly glad to have the opportunity to consider papers of a practical character. Members and non-members who contemplate offering papers are asked to communicate immediately with the secretary of the Institute, who will forward them a copy of the Institute's publication "Notes for the Guidance of Authors of Papers." It is desirable that all formal offers of papers should be sent to the secretary not later than October 1, so that they can be considered by the meeting of the appropriate committee which will be held in mid-October.

P.O.A. Conference and Minibition

During the latter part of this week in Brighton (September 24 to 26), the Purchasing Officers' Association is holding its annual national conference and Minibition, with headquarters at the Hotel Metropole.

The proceedings begin with visitors' day at the Minibition—held in the hotel—which, as the name suggests, is a miniature exhibition at which the stands of manufacturers (over 100 firms are showing) are limited to about 5 by 4 ft. Afterwards there is a civic reception and dance in the Royal Pavilion. Friday, for the menfolk, is devoted to hearing papers mainly on business and association organization, but including one on "Shell Mouldings" by Mr. A. E. Hearne. The ladies listen to a talk on furniture, see an exhibition, and have a coach trip in the afternoon. On Saturday there are to be more technical papers and the annual meeting.

Included among the "foundry" stands at the Minibition are those of Edgar Allen; Ashmore, Benson, Pease; B.T.H.; Crane's, W. H. Dorman; English Steel Corporation; Firth Vickers; G.E.C.; John Harper's;

(*Continued at foot of col. 2*)

City and Guilds Results

The City and Guilds of London Institute has prepared the following Table of results of the examinations in foundry practice and in patternmaking which they conduct, with the co-operation of the Institute of British Foundrymen:—

TABLE I.—*Comparative Statistics for C. & G. Examination Results in Patternmaking and Foundry Practice.*

Year.	Candidates.	1st Class.	2nd Class.	Fail.	Per cent. passing.
		Patternmaking (intermediate).			
1953 ..	361	31	179	151	58.2
1952 ..	306	48	152	106	65.4
1951 ..	292	53	136	103	64.7
1950 ..	313	70	136	107	65.0
1949 ..	208	28	77	103	50.5
1948 ..	115	29	53	33	71.4
1947 ..	94	7	37	50	46.6
1946 ..	78	9	27	42	46.0
1945 ..	59	4	43	12	79.6
1944 ..	39	8	18	13	66.7
1943 ..	46	7	19	20	56.5
1942 ..	22	4	9	9	59.0
		Patternmaking (final).			
1953 ..	165	26	87	52	67.5
1952 ..	173	26	103	44	74.6
1951 ..	131	16	51	64	51.0
1950 ..	83	20	41	22	73.5
1949 ..	72	29	30	13	82.0
1948 ..	34	12	14	8	76.5
1947 ..	28	5	12	11	60.5
1946 ..	25	4	9	12	51.0
1945 ..	21	6	9	6	72.5
1944 ..	19	3	10	6	68.4
1943 ..	19	6	8	5	73.8
1942 ..	24	2	12	10	85.0
		Foundry Practice (intermediate).			
1953 ..	259	49	171	39	84.9
1952 ..	239	35	162	42	72.4
1951 ..	207	29	88	90	56.5
1950 ..	232	40	118	74	68.0
1949 ..	134	14	51	69	48.6
1948 ..	145	15	53	77	46.9
1947 ..	114	41	32	41	64.1
1946 ..	85	33	15	37	56.0
1945 ..	56	19	29	10	69.1
1944 ..	55	11	27	17	69.0
1943 ..	47	13	18	16	66.0
1942 ..	36	7	15	14	61.0
		Foundry Practice (final)			
1953 ..	138	25	37	26	81.2
1952 ..	107	7	77	23	78.5
1951 ..	108	17	43	46	56.6
1950 ..	62	6	27	29	53.0
1949 ..	68	7	27	34	50.0
1948 ..	50	10	19	21	58.0
1947 ..	28	1	6	21	25.0
1946 ..	No examination beyond intermediate stage.				

It will be observed that the results this year in foundry practice show substantial improvement both in numbers of candidates taking the examination and in passes secured, records being achieved in both instances. For patternmaking, the position shows only a slight increase in the number of successes, despite a much larger number of candidates in the intermediate section and for the final grade a decrease in numbers and percentage passes is recorded. It should be borne in mind, however, that the examination papers may not be of comparative "stiffness" from year to year, though this, of course, is an important objective of the examiners.

Hopkinsons; Newman Hender; Newton Chambers; Stanton; the Teconic group and Henry Wallwork—to give their short titles. If this exhibition lives up to the reputation of previous years, then it will indeed be worth seeing and, from the exhibitors' point of view, well worthwhile. Apart from the opening day (11 a.m. to 6 p.m.), it is open on both Friday and Saturday, 8 a.m. to 6 p.m.

Effect of Pouring Conditions on Shrinkage Unsoundness in Bronze Ingots cast in Metal, Carbon or Sand Moulds*

By W. T. Pell-Walpole, D.Sc.

The fact that shrinkage porosity of gas-free bronzes is related to the rate of pouring is first enunciated and then explained. Next, details are given of new research work carried out to determine the effect of both rate and temperature of pouring of bronze cast into moulds of widely-differing thermal characteristics, viz., of metal, carbon and sand. From data so acquired, optimum pouring rates to suit the various conditions have been developed and their application to foundry practice generally is discussed.

It has been established[1, 2] that the extent of shrinkage porosity in gas-free bronzes cast into cast-iron moulds depends mainly on the rate of pouring. Porosity is least when the rate of pouring is the minimum which will fill the mould without cold-shuts: when this rate is used, variation of the temperature of pouring has little effect, but, at higher rates, variation of pouring temperature has more effect than variation of rate. The minimum safe rate of pouring for maximum soundness in cast-iron moulds is related to the size of ingot by the formula: $R = K P$, where R, is the rate of pouring (lb. per min.), P, the periphery of the ingot (in.) and K, a constant depending on metal composition and quality.

Experimentally determined values of K, for commonly used compositions, have been published.[2] This formula has been tested in practice for a wide range of compositions, and, provided that suitable degassing technique is employed to give good metal quality, its use gives a simple, practical method for the control of soundness in bronzes cast in iron moulds up to 3 in. dia. It is now used by many foundries in this country and abroad. The possible extension of the use of this formula to control casting into moulds made of materials other than cast iron, may now be considered.

The theoretical basis for the formula is that optimum soundness is obtained when the pasty zone during solidification is a minimum. This depends on balancing the rate of heat extraction (determined by the periphery of the mould and by the thermal characteristics of the mould) against the rate of heat input (determined by pouring rate and pouring temperature). Substituting for cast iron a mould of greater chilling power should permit the use of a more rapid rate of pouring, while retaining the minimum pasty zone required for optimum soundness: using a mould material of lower chilling power should require a slower rate of pouring for optimum soundness. Thus it has been shown by Kondic and the present Author[1] that, for casting into water-cooled copper moulds, the pouring rate for optimum soundness is higher than for cast-iron moulds; on the other hand, when a thermally insulating type of mould-dressing is used on cast-iron moulds, a slower rate of pouring is required to give optimum soundness.

The present research is an investigation of the effect of rate and temperature of pouring on the soundness of bronze cast into moulds of widely differing thermal characteristics, *viz.*, metal moulds, carbon moulds and sand moulds.

* Presented at the fiftieth annual meeting of the Institute of British Foundrymen.

EXPERIMENTAL CONDITIONS

In order to reduce the amount of experimental work to within reasonable limits, it was necessary to standardize on one alloy composition and one size of casting. Bearing bronze of high-phosphorus content (10 per cent. tin, 1.5 per cent. phosphorus) was chosen as a suitable composition, since this alloy is very fluid and can be cast at widely varying rates and temperatures of pouring. Also the last liquid to solidify in this alloy, does so at a constant temperature, thus permitting easy measurement of solidification times in the various moulds employed.

The bronze was prepared from virgin metals (electrolytic copper scrap and Chempur tin), melted in a gas-fired pit-type crucible furnace, and degassed with an oxidizing flux (equal parts of CuO, fused borax and sea sand). Temperatures were measured with a direct immersion, chromel/alumel couple, and pouring rates were controlled by top pouring through a plumbago crucible drilled with the requisite size of hole.

The moulds were prepared to give a simple cylindrical casting 10 in. long by 1 in. dia. The mould wall thickness varied from 1½ to 2½ in., but independent investigations not reported here in detail established that such variations had no effect on solidification time with the mould materials used. The mould materials investigated were:—

(*a*) A cast-iron mould of 1½ in. wall thickness, included to give a standard of comparison for the other moulds.

(*b*) A copper mould of 2½ in. wall thickness.

(*c*) A mould machined from a block of electrode carbon, walls 1½ to 2 in. thick.

(*d*) A mould made by packing steel shot round a 1 in. dia bronze-foil cylinder in an outer casing of thin sheet steel 3 in. dia.

(*e*) A mould consisting of 75 per cent. Southport sea sand, 25 per cent. plumbago, packed round a 1 in. dia. bronze-foil cylinder in an outer casing of thin sheet steel, 3 in. dia.

(*f*) A mould made of Southport sand bonded with 1½ per cent. of dextrin. This mould was used with a liner of bronze foil as for (*d*). This prevents gas absorption from the bonded sand, which would otherwise affect the amount of porosity produced in the castings.[3]

F

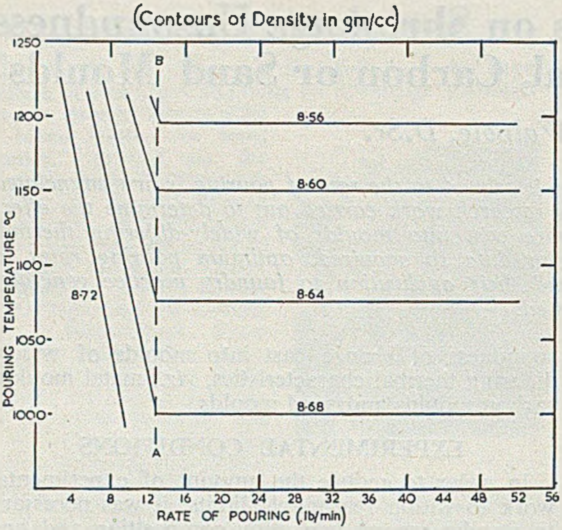

FIG. 1.—*Density Map for Phosphor-bronze Ingots cast in an Iron Mould.*

The solidification time for the bronze in each of these moulds was determined with a thermocouple secured at the centre of the mould cavity. Cooling curves were made for metal cast at temperatures varying from 1,050 to 1,200 deg. C. Solidification times were taken as the interval between the commencement of the liquidus and the end of the solidus arrest. It was found that, with the metal and carbon moulds, solidification time did not vary appreciably with these variations in pouring conditions; with the aggregate moulds, the higher pouring temperatures increased the solidification time. (Table 1.)

With each mould, an extensive series of ingots was then cast at various rates and temperatures of pouring (see Table II), for studying the effect of

TABLE I.—*Solidification Times for Phosphor-Bronze Ingots (1 in. dia.) in Various Moulds.*

Mould.	Pouring temp., deg. C.	Solidification time (secs.). Observed.	Solidification time (secs.). Mean	Mould dia. (in.).	*S/D²
Iron	1,200	24	20	1.00	20
	1,100	20			
	1,100	18			
	1,100	18			
Copper	1,200	22	20	1.10	16.5
	1,200	20			
	1,100	19			
Carbon	1,150	30	28	.06	25
	1,150	28			
	1,100	25			
	1,100	30			
Steel shot ..	1,175	100	150	1.00	150
	1,120	145			
	1,000	140			
Sand/plumbago	1,225	240	220	1.00	220
	1,200	215			
	1,170	200			
Sand/dextrin ..	1,200	305	280	1.00	280
	1,050	255			

* S/D² = Equivalent solidification time for ingot 1·00 in. dia. (values used in graphs, Figs. 7 to 10).

TABLE II.—*Details of Pouring Conditions for Porosity Tests.*

Mould.	Rate, lb. per min.	Temp., deg. C.	Bars.
Iron ..	4	1,200	1
	8	1,200	2
	8	1,100	1
	8	1,075	1
	12	1,200	1
	12	1,000	1
	16	1,200	1
	16	1,100	1
	30	1,200	3
	30	1,100	1
	30	1,000	1
Copper	3	1,150	1
	6	1,200	2
	6	1,150	2
	6	1,100	1
	9	1,200	2
	9	1,150	1
	9	1,100	1
	13	1,200	1
	13	1,150	1
	13	1,100	1
	13	1,050	1
	13	1,000	1
	24	1,200	1
	24	1,150	1
	24	1,100	1
	24	1,050	1
	24	1,000	1
	24	1,200	1
	24	1,100	1
Carbon	2.8	1,300	1
	2.8	1,200	2
	2.8	1,150	2
	4.2	1,225	1
	4.2	1,200	1
	4.2	1,100	1
	9	1,200	2
	9	1,150	1
	9	1,050	2
	15	1,150	3
	15	1,100	2
	15	1,050	3
	21	1,200	2
	21	1,150	1
	21	1,050	2
	21	950	1
	34	1,200	2
	34	1,150	1
	34	1,100	1
	34	1,000	1

Mould.	Rate, lb. per min.	Temp., deg. C.	Bars.
Steel shot	1.5	1,200	2
	2.5	1,200	1
	2.5	1,150	1
	2.5	1,100	1
	2.5	1,075	1
	3.0	1,200	2
	3.0	1,150	2
	3.0	1,100	2
	4.0	1,150	2
	4.0	1,100	1
	4.0	1,025	1
	6	1,250	1
	6	1,100	1
	6	1,050	2
	20–24	1,250	1
	20–24	1,200	2
	20–24	1,150	2
	20–24	1,100	3
	20–24	1,050	3
	20–24	1,000	2
	20–24	950	1
	40	950	1
Sand/dextrin	4	1,200	1
	4	1,125	3
	4	1,100	2
	4	1,050	1
	6	1,200	1
	6	1,150	1
	6	1,100	1
	6	1,000	1
	8	1,200	1
	8	1,100	1
	12	1,200	1
	21	1,200	1
	21	1,100	1
	21	1,000	1
	60	1,000	1
Sand/plumbago	2	1,200	1
	2	1,130	1
	4	1,250	1
	5	1,250	1
	5	1,200	1
	5	1,150	1
	5	1,100	1
	5	1,050	1
	15	1,250	1
	15	1,200	1
	15	1,175	1
	15	1,125	1
	15	1,050	1
	40	1,000	1
	40	950	1
	40	900	1

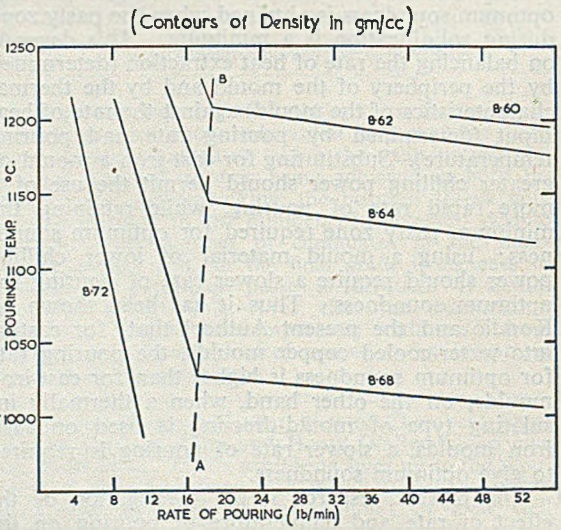

FIG. 2.—*Density Map for Phosphor-bronze Ingots cast in a Copper Mould.*

these variables on porosity. Density measurements were adopted as the simplest measure of porosity. A piece 1 in. long was removed from the top of each ingot and a surface layer of metal $\frac{1}{16}$ in. deep was machined away, before density determinations were made.

The apparent density at 15 deg. C. was then determined by the Archimedes method. The maximum attainable density of a cast bronze varies with the phosphorus content: a variation of ± 0.07 per cent. P causes a variation of density of ± 0.02 gm. per c.c. The latter is the estimated accuracy of the density determinations, so that variations of phosphorus content within this range will have no appreciable effect on the density value. All the ingots were analysed for phosphorus content and the few which were outside this permitted range of variation were rejected and replaced by other ingots within the required composition range. The experimental results are plotted in Figs. 1 to 6 as contour graphs of density against rate and temperature of pouring for the various moulds examined.

Results

Iron Mould

The variations of density with rate and temperature of pouring for the iron mould are shown in Fig. 1. The general form of this graph is similar to those published previously for low-phosphorus bronzes and for gun-metal, but the extent of variation in density over the range of conditions examined is less for the high-phosphorus bronze. There are two reasons for this: (*a*) the high fluidity of this bronze, (*b*) its ability to undergo mass feeding, owing to the fact that it always solidifies by the formation of equi-axed crystals simultaneously across the section, without shell formation.

The density map forms two distinct regions

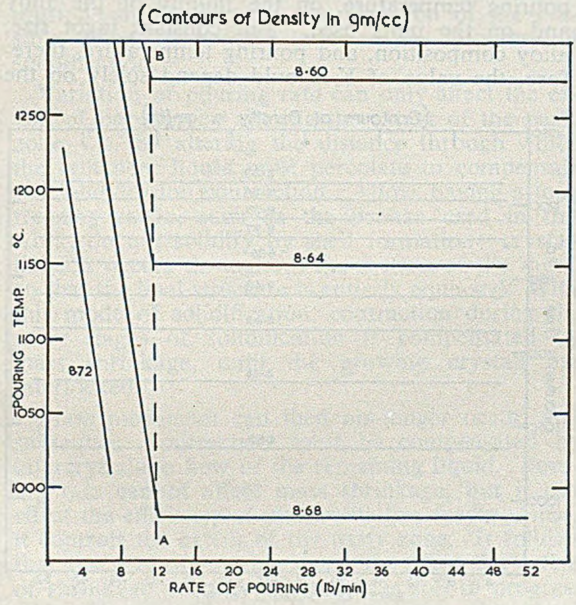

FIG. 3.—*Density Map for Phosphor-bronze Ingots cast in a Carbon Mould.*

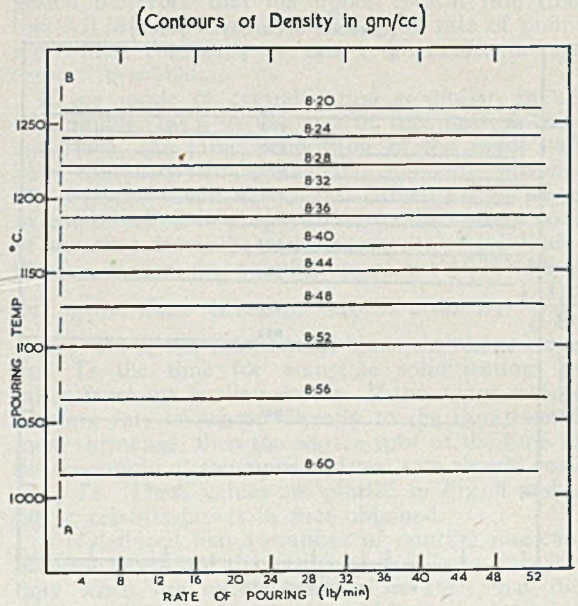

FIG. 4.—*Density Map for Phosphor-bronze Ingots cast in a Steel-shot Mould.*

divided by the broken line, AB. To the left of AB, density improves rapidly as the rate of pouring is increased, and slightly, as pouring temperature is decreased. To the right of AB, pouring rate has virtually no effect, the density being determined solely by the temperature of pouring. The significance of the line AB will be discussed later.

Copper Mould

The density map of the copper mould, Fig. 2, is similar in form to that for the iron mould, but has several important differences in detail:—(*a*) the optimum density is obtained at a slightly higher pouring rate, and (*b*) the line AB, (which marks the upper limit of the range in which density varies with pouring rate) is displaced markedly to the right. These effects are related to the greater chilling power of the copper mould.

Carbon Mould

The density graph for ingots cast in the carbon mould (Fig. 3) is also similar in general form to those for the iron and copper moulds, but with the following differences in detail:—(*a*) The pouring rate to give optimum density is slightly lower than that for the iron mould. (*b*) The line AB dividing the two regions of the map is displaced slightly to the left, in relation to its position on the corresponding map, for the iron mould, *i.e.*, with the carbon mould, the region in which pouring rate is the potent factor controlling density is restricted to lower rates than with the iron mould. These effects (*a*) and (*b*) appear to be related to the slower rate of solidification. (*c*) In the region in which pouring temperature is the only factor affecting density, the variation of density with pouring temperature is less pronounced for the carbon mould than for the metal moulds. This is the reverse of what might be expected from the

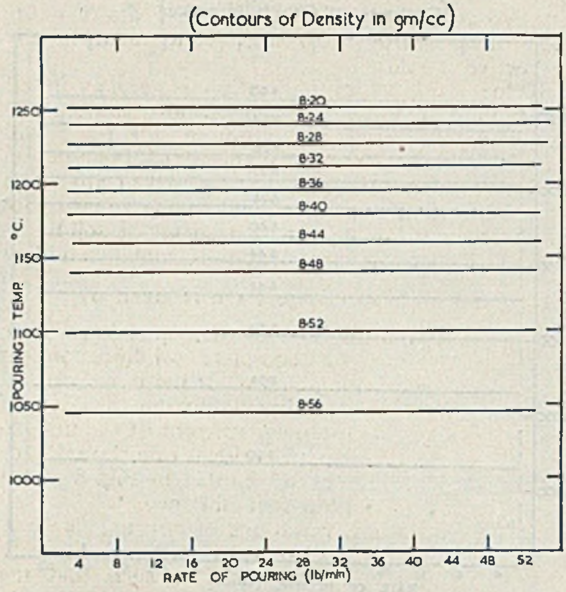

FIG. 5.—*Density Map for Phosphor-bronze Ingots cast in a Sand/Plumbago Mould.*

lower rate of solidification in the carbon mould. The apparent anomaly can probably be explained with reference to gas absorption from mould dressings. With either of the metal moulds, combustible mould dressings have to be used. It has been established previously[4] that such dressings cause slight gas absorption, particularly when high pouring temperatures are used. The decrease of density with increase of pouring temperature is slightly exaggerated by this effect with any of the metal moulds. Mould dressing is not necessary with the carbon mould, hence the latter gives slightly higher densities for equivalent pouring conditions, particularly with high pouring temperatures.

Aggregate Moulds

The density maps for all the aggregate moulds, Figs. 4 to 6, are similar to one another, but differ from the maps for the preceding moulds in that the contours of density are parallel to the rate axis for the whole range of conditions examined (4 to 56 lb. per min., 1,000 to 1,200 deg. C.). Thus with these moulds, which are characterized by having a much lower chilling power (a higher solidification time) than the foregoing, the region in which pouring rate has no effect on density is extended to the lowest rate which can be conveniently used in practice. With these moulds, some additional tests were made with even slower rates of pouring (1½ to 2 lb. per min.). Under these conditions, which could only be used with a pouring temperature of 1,200 deg. C. or higher, a slight increase in density was obtained, notably with the steel-shot mould.

It appears therefore, that even with the aggregate moulds, the general relationship between density and pouring conditions is similar to that for the carbon and metal moulds. With the aggregate moulds, however, due to the slow rate of solidification of the bronze, the pouring rate is only effective in controlling density when the rate is less than 2 lb. per min. Such slow rates involve the use of very high pouring temperatures and of small pouring apertures, which are difficult to control in practice. In contrast to this slight effect of pouring rate on density pouring temperature has a more marked effect than with the chill moulds. The highest densities attainable are appreciably lower than those obtained with chill moulds under corresponding conditions of pouring.

CONSIDERATION OF RESULTS

1.—Effects of Pouring Rate on Density

The relationship between pouring rate and density is fundamentally the same whatever mould material is used. For a constant pouring temperature, maximum density is obtained with the minimum rate which will give a complete ingot free from cold-shuts. As the rate of pouring is increased, the density of the ingot obtained decreases rapidly until a second critical rate is reached. Beyond this, further variation of rate has no appreciable effect on density. For a constant ingot size, the values of both the minimum safe rate (giving optimum density) and of the upper critical rate depend on the chilling power of the mould material. The greater the chilling power the higher are the values of the critical rates.

Minimum Safe Pouring Rate for Optimum Density.

It has been established previously, and discussed in the introduction to this Paper, that for iron moulds, the lower critical rate required to give optimum density is given by the formula: $R = KP$ (lb. per min.), where R is the pouring rate, P the periphery of the mould (in.); and K a constant depending on thermal properties of the mould, on pouring temperature, on the fluidity of the alloy and on the units used. For constant ingot size, alloy composition, and pouring temperature, therefore, the value of K should depend solely on the

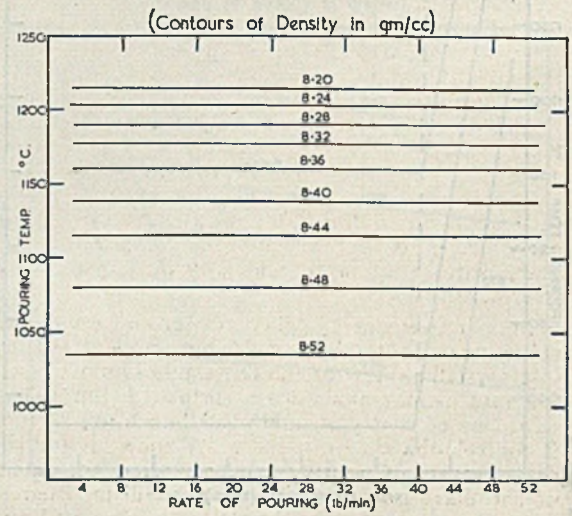

FIG. 6.—*Density Map for Phosphor-bronze Ingots cast in a Sea-sand/Dextrin 1 per cent. Mould.*

thermal characteristics of the mould. Applying this formula to the results of the present investigation, the values of K, for a pouring temperature of 1,100 deg. C. are 1.9 for the iron mould, 1.45 for the carbon mould, 2.4 for the copper mould and <0.6 for the aggregate moulds. These values of K for the various mould materials can now be expressed in terms of the K value to the iron mould: $K_x = CK_{Fe}$, where K_x=the K value of the new mould material. K_{Fe}=the K value of the iron mould and C=a constant for a given mould material. The general formula may now be applied to any mould material: R=CKP, where R, K and P have the same values as in the original formula. The values of C are 1.0 for iron, 1.25 for copper, 0.75 for carbon and <0.35 for the aggregate moulds. If C in this formula is a function of the chilling power of the mould material, the value of C for each mould should bear some simple relationship to the solidification time for that mould. That this is so is illustrated in Fig. 7 in which the values of C are plotted against the appropriate values of solidification time.

Upper Critical Rate.

If solidification does not commence until the mould is full, pouring rate can have no direct effect on solidification and hence no effect on density. This might explain the constant density of ingots cast in aggregate moulds at rates >16 lb. per min., since filling time at these rates is less than 20 secs., while solidification does not commence until 20 secs. after the commencement of pouring. However, reducing the pouring rate from 16 to 4 lb. per min. still has no effect on density, but with this range of pouring rate, solidification starts before pouring is completed. Hence, the upper critical rate cannot be the limiting rate which will fill the mould before solidification commences. Some other explanation of its significance must be sought, from a consideration of the possible effect of pouring rate on the progress of solidification.

Variation of pouring rate can only affect the extent of porosity by altering the extent of the pasty zone, *i.e.*, by altering the distance through which the remanent liquid must percolate to compensate for solidification contraction. Alloys having a long freezing range, such as the bronze used in this work, do not solidify by shell formation: crystallization occurs throughout the section of the ingot, so that the final structure is entirely equiaxed. With this mode of solidification, contraction during the early stages of solidification is compensated by mass shrinkage, until the growing crystals are interlocked.

Mass movement can then no longer occur, and subsequent contraction must be compensated by intercrystalline flow of the remaining liquid. Pouring rate cannot affect mass shrinkage, but it can effect the efficiency of intercrystalline feeding, since it controls the extent of the pasty zone. It follows that the rate of pouring can only affect the extent of shrinkage porosity if pouring is still in progress when the stage of mass shrinkage is completed and intercrystalline feeding is in progress. It is suggested therefore that the upper critical rate (the line AB in Figs. 1 to 4) is the highest rate of pouring which conforms to this requirement in the respective moulds.

If the mode of crystallization is similar, in all the moulds, then, at the end of the mass shrinkage stage, the same proportion of the ingot will have solidified. From available data, the proportion of solid metal which has formed at any stage of solidification is proportional to the square root of the time from the commencement of solidification. Hence the proportion of metal solidified during the mass shrinkage stage is given by $\frac{\sqrt{Tm}}{\sqrt{Ts}}$ where Tm is the duration of mass shrinkage stage and Ts the time for complete solidification, as taken from the cooling curves. If the upper critical pouring rate is related directly to the duration of mass shrinkage, then the square root of the time to fill the mould at this upper critical rate should vary as $\sqrt{Ts}$. These values are plotted in Fig. 8 and a linear relationship is in fact obtained.

It is deduced that variations of pouring rate can be used to control the extent of shrinkage porosity only when the mould material is such that the upper critical pouring rate is within the practicable range (*i.e.*, not less than 4 lb. per min.). The results of the present work indicate that this condition is given only by mould materials of high chilling power, such as water-cooled moulds and moulds machined from solid blocks of metal or carbon. A mould made from steel shot gives a value of the upper critical rate which is just within the practicable range, while, with all sand moulds, the upper critical rate is below the practicable limit. Consequently, reduction of pouring rate cannot be used to decrease shrinkage porosity in ingots cast in sand moulds of normal composition.

2.—Effects of Pouring Temperature on Density

Pouring temperature has little effect on shrinkage porosity (as determined by density measurements on gas-free metal) when the pouring rate is less than the upper critical rate for the mould in use. When the pouring rate is above the upper critical rate then temperature becomes the most potent variable affecting shrinkage porosity. The relationship

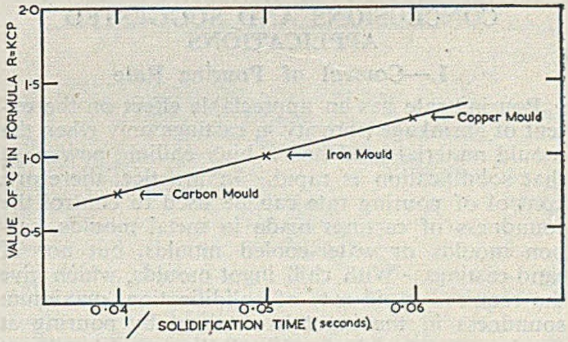

FIG. 7.—*Relationship between Value of "C," in Formula R=KCP, and Solidification Time for Phosphor-bronze Ingots of Equal Diameter cast in Various Moulds.*

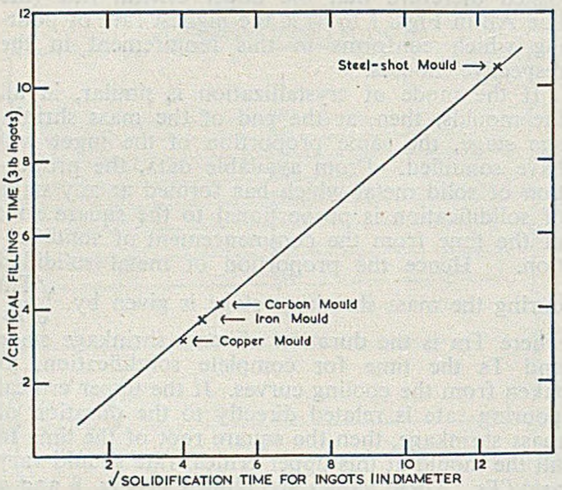

FIG. 8.—*Relationship between Critical Filling Time and Solidification Time (for 3-lb. Phosphor-bronze Ingots 1-in. dia.).*

between pouring temperature and density at high pouring rates is shown in Fig. 9. The curves are nearly linear for each mould, but the gradient increases slightly for temperatures above 1,100 to 1,150 deg. C., particularly with the aggregate moulds. The effect of temperature throughout the range examined is also much greater with these moulds than with the metal and carbon moulds of high chilling power.

3.—Effects of Mould Material on Density

The effects of the mould material have already been considered in relation to the effects of pouring rate on porosity, but when solidification is so slow that the rate of pouring has no effect on density, the effects of the mould material become more important. When these conditions apply (*e.g.* in casting into aggregate moulds) then, for a constant pouring temperature, the density of the ingot varies inversely as the square root of the solidification time (Fig. 10), *i.e.*, directly as the chilling power of the mould material.

CONCLUSIONS AND SUGGESTED APPLICATIONS

1.—Control of Pouring Rate

Pouring rate has an appreciable effect on the extent of shrinkage porosity in castings only when the mould material used had a high chilling power, so that solidification is rapid. In practice, therefore, control of pouring rate can be used to control the soundness of castings made in metal moulds, carbon moulds or water-cooled moulds, but not of sand-castings. With chill ingot moulds, which give the required rapid rate of solidification, maximum soundness in the ingot is obtained by pouring at the lowest rate which will fill the mould without the formation of cold-shuts. This rate is given by the empirical formula:—R=KCP, where R, is the pouring rate in lb. per min.; C, the ratio of chilling power of the mould to the chilling power of a cast-iron mould of the same size; P, the periphery of the mould cavity (in.) and K, a constant depending on the composition of the bronze to be cast. The values of C determined in the present investigation are: with a copper mould, C=1.25; with a carbon mould, C=0.75, and with a cast-iron mould, C=1.

The values of K, for a wide range of composition have been determined previously. For the usual range of foundry bronzes, only two values of K need be considered: for Admiralty gunmetal (88/10/2) leaded gunmetals, and low-phosphorus bronzes, with tin contents of 7 to 12 per cent., a value of K=1.9 will be found suitable. For ingots of high-phosphorus bronze (*e.g.*, bearing bronze containing 10 per cent. tin, 0.5 per cent. phosphorus) and of high-tin gear bronze (*e.g.*, 12 to 13 per cent. tin, 0.3 to 0.5 per cent. phosphorus) the greater fluidity permits a lower value of K=1.3 to be used.

Pouring rate can be controlled by top, axial pouring through a plumbago pouring basin, with a clearly drilled, vertical aperture of the appropriate diameter. Since the rate of pouring varies as the square of the diameter of the aperture, the latter must be kept within close limits for satisfactory control to be obtained. Suitable rates and the corresponding apertures for casting some of the smaller sizes of stick ingot, using iron, copper or carbon moulds, are given in Table III.

It has been stated that in sand casting, variation of pouring rate has no appreciable effect on bulk shrinkage porosity, hence in this class of work the

TABLE III.—*Pouring Rates for Optimum Soundness with Copper, Iron or Carbon Moulds.*

Alloy type.	Ingot dia. (in.)	Mould material.	Rate, lb. per min.	Nearest practicable aperture dia. (in.).*
Admiralty gunmetal, leaded gunmetals, and low-phosphorus bronzes	< 1	Cast iron Copper Carbon	6 8 4½	$\frac{7}{64}$ $\frac{1}{8}$ $\frac{3}{32}$
	1 to 1½	Cast iron Copper Carbon	9 12 7	$\frac{1}{8}$ or $\frac{9}{64}$ $\frac{5}{32}$ $\frac{7}{64}$ or $\frac{1}{8}$
	1½ to 2	Cast iron Copper Carbon	12 16 9	$\frac{5}{32}$ $\frac{3}{16}$ $\frac{1}{8}$ or $\frac{9}{64}$
	2 to 2½	Cast iron Copper Carbon	15 20 11	$\frac{3}{16}$ $\frac{3}{16}$ or $\frac{7}{32}$ $\frac{9}{64}$ or $\frac{5}{32}$
	2½ to 3	Cast iron Copper Carbon	18 24 13½	$\frac{3}{16}$ or $\frac{7}{32}$ $\frac{7}{32}$ $\frac{5}{32}$ or $\frac{3}{16}$
Bearing bronzes (10 per cent. Sn, 0.5 per cent. P), gear bronzes (12 per cent. Sn, 0.3 per cent. P), and other high-tin or high-phosphorus bronzes	<1	Cast iron Copper Carbon	4 5 3	$\frac{3}{32}$ $\frac{7}{64}$ or $\frac{3}{32}$ $\frac{3}{32}$†
	1 to 1½	Cast iron Copper Carbon	6 8 4½	$\frac{7}{64}$ $\frac{1}{8}$ $\frac{3}{32}$
	1½ to 2	Cast iron Copper Carbon	8 10 6	$\frac{1}{8}$ $\frac{9}{64}$ $\frac{7}{64}$
	2 to 2½	Cast iron Copper Carbon	10 12 7½	$\frac{9}{64}$ $\frac{5}{32}$ $\frac{1}{8}$
	2½ to 3	Cast iron Copper Carbon	12 15 9	$\frac{5}{32}$ $\frac{3}{16}$ $\frac{1}{8}$ or $\frac{9}{64}$

* When two possible apertures are given, use the larger for the larger sizes of the quoted range.
† Lowest practicable aperture = 4 lb. per min.

pouring rate can be controlled solely with a view to the most satisfactory filling and feeding of the mould. The control of pouring rate for these purposes is outside the scope of the present investigation, but other works[8-11] have from time to time proposed formulæ for the control of filling time or of pouring rate, some based on practice, some on theoretical considerations.

With shaped castings made in metal moulds, *e.g.*, gravity die-castings, pouring rate is probably important both from the aspect of satisfactory filling and for the control of shrinkage, but little experimental work is available to place this problem on a quantitative basis.

2.—Control of Pouring Temperature

The results of this investigation show that when solidification takes place very rapidly, *i.e.*, with chill ingot moulds and slow pouring rate, then variation of pouring temperature has little effect on shrinkage porosity. On the other hand, with sand castings, when solidification is prolonged, pouring temperature is one of the most potent factors affecting the extent of shrinkage porosity.

In practice, therefore, a clear distinction is necessary as to the control available by varying the pouring temperature for chill castings on the one hand and for sand castings on the other. When chill ingot castings are being made from degassed metal with the ideal rate of pouring recommended in Table III, the effects of varying pouring temperature (within reasonable limits) on shrinkage porosity can be ignored. That being so, pouring temperature can be selected to give the most desirable type of microstructure in the castings. In general, high pouring temperatures tend to give finely distributed pools of $(\alpha+\delta)$ phase in the cored α matrix while low pouring temperatures give semi-continuous, intercrystalline envelopes of this complex. The former microstructure gives high ductility and lower hardness, the latter gives high hardness and rigidity with a marked decrease in ductility. The most satisfactory ranges for the best all-round mechanical properties for degassed metal poured at the recommended rates are 1,125 to 1,175 deg. C. for the high-phosphorus bronzes, and 1,175 to 1,225 deg. C. for low-phosphorus bronzes and gunmetals. If the metal is not degassed, however, these pouring temperatures would give rise to considerable gas porosity, and much lower temperatures would be necessary.

In contrast to its relatively slight effect in chill casting, pouring temperature is certainly one of the most vital factors in sand casting. Even when the metal has been degassed and is isolated from the harmful effects of mould reactions during pouring, as in the investigations reported here, the density of the casting obtained decreases very rapidly as pouring temperature is increased. If this were the only effect to be considered, then the lowest possible casting temperature would give the best result. In practice, with shaped castings, however, pouring temperature must be dictated, at least in some measure, by other considerations.

The satisfactory running of the casting is the first essential, and attention must be paid to the distance the molten metal has to run from the ingate, and the relative positions of light and heavy sections, in order to avoid misruns or the entrapping of air or core gases by the solidifying metal before these have had time to escape. These factors alone often preclude the use of the very low temperatures which give the maximum density in a simple top-poured test-bar. Secondly, the effects of pouring temperature on structure must be considered. The general variations in structural distribution with pouring temperature are similar to those discussed under chill castings, but with shaped sand castings conditions are more complex, since variations of section also affect structure. In general, however, the most satisfactory structures in sand-cast bronzes are obtained at rather lower pouring temperatures than those mentioned for chill casting, *e.g.*, 1,130 to 1,200 deg. C. for gunmetal, 1,050 to 1,100 deg. C. for phosphor-bronzes.

A third factor which should be considered in practice is the relation of pouring temperature to the mould reaction. By this reaction, the molten metal absorbs hydrogen mainly from the combined water of the sand mould, but the effects are slight if the pouring temperature is below 1,050 deg. C. for high-phosphorus bronzes or below 1,175 deg. C. for admiralty gunmetal and other bronzes which contain only traces of phosphorus. In well-fed castings, it is generally desirable to avoid gas absorption completely, so that with such castings the lowest casting temperature consistent with efficient running would both give protection from gas absorption and ensure the lowest amount of general shrinkage porosity. In complex shapes, which are difficult or impossible to feed perfectly, a controlled amount of gas absorption will often give a better distribution of porosity as between heavy and light sections and in hydraulic castings will thereby improve pressure-tightness. In this case, a casting temperature well above that indicated as best for a well-fed bar might give a superior casting.

It may be concluded that while solidification shrinkage in a sand-cast test-bar can be reduced to a minimum by using the lowest possible pouring temperature, this procedure is only acceptable for shaped castings if: (*a*) the temperature is sufficient for satisfactory running of the casting; (*b*) the rather brittle type of microstructure produced by a

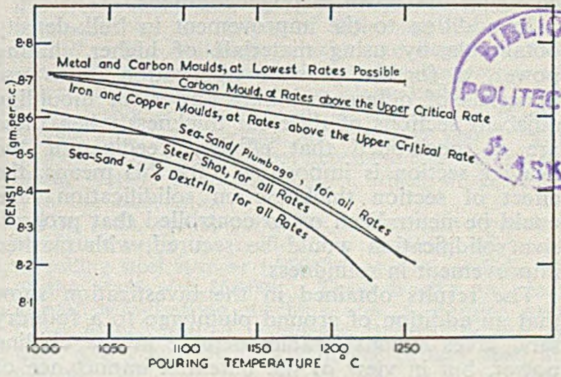

FIG. 9.—*Effect of Pouring Temperature on Density of Phosphor-bronze Ingots.*

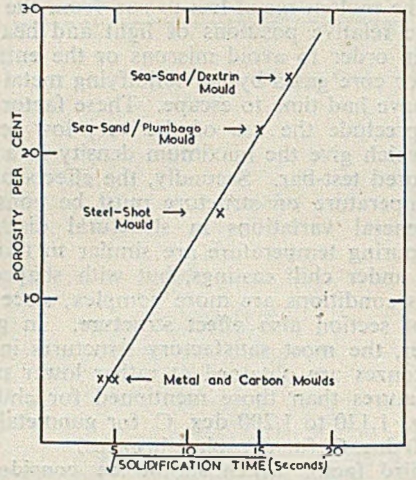

FIG. 10.—*Effect of Solidification Time on Porosity of Ingots. (For Rates exceeding the Upper Critical Rate for each Mould. The Pouring Temperature was* 1,000 *deg. C.)*

very low casting temperature is acceptable; or (*c*) if the casting is of a simple design which can be reasonably well fed, so that gas absorption *via* the mould-reaction is not necessary to avoid local concentrations of shrinkage porosity.

3.—Control of Chilling Power of the Mould Material

The present investigation has shown (see Fig. 10) that, for a given set of pouring conditions, the density of a casting of given section (representing the amount of shrinkage porosity) varies directly as the chilling power of the mould material (*i.e.*, inversely as the square root of the solidification time). Since foundry sands have a very low chilling power, sand castings commonly exhibit more shrinkage porosity than chill-cast ingots. If the chilling power of foundry sands could be appreciably increased by suitable additions, without adversely affecting their other essential properties (such as workability, strength, permeability and refractoriness) then it should be possible to obtain a better bulk-density in a shaped casting, without changing the other casting conditions.

In addition to the improvement in bulk-density obtainable by using materials of higher chilling power, a further possible application is to use materials of different chilling power for moulding adjacent sections of different thickness when these are so positioned that efficient feeding of the heavier section is impossible. By this means, the effect of section thickness on solidification time could be neutralized or so controlled that progressive solidification would be secured, with marked improvement in soundness.

The results obtained in the investigation show that an addition of ground plumbago to a foundry sand gives a considerable increase in the chilling power, but in view of the potential importance of this aspect of the work, a more extensive investigation of the effect of various additions on the chilling power of sands has been undertaken by the Author, and will be reported in a separate communication.

Acknowledgments

This work was carried out in the Department of Metallurgy, Birmingham University. The Author wishes to acknowledge financial support in the form of an I.C.I. Fellowship. He is also indebted to Professor Hanson, director of the Department, and to Professor Murphy, Professor of Industrial Metallurgy, for laboratory and other facilities. He also acknowledges with gratitude the financial and technical assistance given to him by the Tin Research Institute throughout the course of this investigation.

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DISCUSSION

MR. LOGAN, referring to the conclusion under the heading "Control of Chilling Power of the Mould Material," said the statement was made there that "Since foundry sands have a very low chilling power, sand castings commonly exhibit more shrinkage porosity than chill-cast ingots. If the chilling power of foundry sands could be appreciably increased by suitable additions, without adversely affecting their other essential properties (such as workability, strength, permeability and refractoriness) then it should be possible to obtain a better bulk-density in a shaped casting, without changing the other casting conditions." It would probably be accepted by everybody present that with regard to the use of sand moulds in non-ferrous foundry practice the controlling factor was very largely that of pouring temperature. The Author went on to suggest—and he hoped to be forgiven for pointing out that it was not a new suggestion—that if founders could add something to the sand which would materially improve the chilling effect then the casting would be materially improved. That had been said many years ago, by Mr. F. Hudson, and he himself at intervals over a very long period had advocated the very same thing. The use of silicon carbide as a chilling element had been advocated, and it had always surprised him that non-ferrous foundrymen had not experimented more in that direction. The idea was undoubtedly very important and should be followed up by foundries generally, to their advantage. In that connection he understood that Dr. Pell-Walpole was doing further experimental work to find suitable chilling additions, and he looked forward to reading his reports.

DR. PELL-WALPOLE, in reply, apologized for having apparently given the impression in the last paragraph of his Paper that he believed it to be an original suggestion. He was well aware of the earlier work on the subject, particularly Mr. Frank Hudson's, using both Carborundum and various types of steel shots. The last section of the Paper was an attempt to supplement the rather academic approach of the earlier part and to present the work in the more general field of foundry practice. It was not considered necessary to give extra references in this section.

Ground Crucibles Advocated

MR. REYNOLDS said that having read a fair amount of the work done on the chilling power of various materials in the sand mould, by Mr. Hudson and the president of the Institute, on carborundum, clay, and various other additions; they had tried a readily available material, namely ground crucibles, and they had found that by introducing the powdered material into the facing sand they got a better chilling effect. It was true that a slightly rougher casting was obtained than with normal facing sand, but curiously enough, on tests a metal of higher tensile resulted. The comparisons were made on 88:10:2 gunmetal, but seemed fairly general in application.

His firm had also tried it—in connection with cores where there was danger of metal penetration when casting phosphor bronze—as a dilution material of linseed oil and "compo" for oil sand cores. They found they could use less linseed oil and "compo" and yet get a good bond, and also get greater freedom from porosity in the castings, as well as a better skin.

DR. PELL-WALPOLE, in reply, said he was very glad indeed to have a contribution about something which had been tried in practice, because the very materials which Mr. Reynolds had mentioned were among those which he had himself been testing out in quantitative comparison with various ordinary sands, and he could bear out that there was a very marked improvement in the chilling power. He was also very pleased to hear that this was accompanied by a worth-while improvement in the properties of the material.

MR. REYNOLDS added that with oil-sand cores, which were rather harder and more difficult to knock-out than, say, the resin-bonded cores, the crucible-powder addition gave one better knock-out properties.

DR. PELL-WALPOLE replied that it was quite unusual to find things working out that way; normally when one got a bright idea from theory and then tried it out, a number of practical snags were encountered.

Grinding-wheel Material

MR. MALCOLM BROWN suggested that experimentally-minded moulders requiring a ready source of moulding material with good chilling qualities, should collect the old grinding wheels from their fettling shops, put them in a furnace and raise them to about 800 deg. C., which would burn out the bond. This would leave well-graded material, simple to mill-up for use in a mould or as a core.

A MEMBER said that although he had not used them quite in that form he had used the stub of a grinding wheel, which was otherwise finished with, as a direct chill. One obtained rather a rougher casting but the material certainly had a pronounced chilling effect.

MR. RUDDLE said the Paper described a most useful piece of work; he had been particularly interested in the moulding materials of different chilling powers which had been tried, because he had himself done some work on the chilling powers of moulds a few years previously.* One material which was believed to have some practical possibility, although there was difficulty in its adoption owing to the high price, was silicon carbide. They had found that the chilling power of silicon carbide—bonded with bentonite—was about three times that of ordinary moulding sand, and he thought that the use of such a material would greatly improve the soundness of many castings. If a suitable grade of silicon-carbide grit were selected, moulding presented no difficulty.

He pointed out that the factor for the chilling power used by Dr. Pell-Walpole was proportional to the solidification time, whereas most workers used a slightly different factor which was proportional to the square root of the solidification time. Dr. Pell-Walpole's factor was in effect the square of that used by most other workers.

DR. PELL-WALPOLE, in reply, said Mr. Ruddle's own work on that subject was very well known and extremely valuable, and the small contribution which he had himself made only confirmed, by way of showing the effect on porosity, what Mr. Ruddle and many other people had propounded when they showed that different moulding materials gave improvement in chilling power in thermal experiments. He apologized for the fact that in certain places in the Paper direct solidification time had been used rather than the square root. The chilling factor was, of course, proportional to the square root of the time and not proportional to the time.

THE CHAIRMAN, concluding the session, proposed a vote of thanks to the Author, which was carried with acclamation.

The new laboratories of the British Iron and Steel Research Association, in Hoyle Street, Sheffield, will be opened by the Duke of Edinburgh on November 19. The buildings, which were begun in 1950, comprise a three-storey block of laboratories and offices and two single-storey plant buildings which house heavy equipment such as steelmaking plant, a rolling mill, and forging and drawing plant. Estimated to cost £250,000, they accommodate also the staff of the Cutlery Research Council, which works closely with the association.

The 14-in. rolling mill, for research into problems associated with the cold-rolling of strip, is capable of rolling steel strip at 1,750 ft. per min., and the cost of the plant was £60,000. There is also an experimental wire-drawing machine and a forging press. Other plant installed includes a steelmaking arc furnace, and a high-frequency furnace to melt steel in a vacuum.

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* R. W. Ruddle and A. L. Mincher, *Jnl.* Inst. Metals, 1949-50, 76 43.

Electric Smelting of Non-ferrous Metals

In the course of an article "Electric Smelting of Minerals"* by A. G. Robiette, M.SC., F.I.M., mention is made of electrical extraction methods applied to non-ferrous metals, from which the following is taken:—

Copper and Nickel

Copper and nickel smelting can be grouped together, as one of the usual processes of extraction from the mineral consists of separating the sulphide ores by flotation and smelting the concentrates to form a matte which is subsequently blown. Sometimes, part of the concentrates are roasted, if there is a market for sulphuric acid.

In countries such as Canada, the U.S.A. and Northern Rhodesia, these concentrates are melted in reverberatory furnaces, but in Scandinavia and also in Finland a closed-roof electric furnace, similar to an electric pig-iron furnace, was developed. Furnaces of this type have been used since before the war in Finland and Norway, and latterly also in Sweden. The nickel-smelting plant at Petsamo, in what was Finland before 1945 (now Russia), was designed in this country on the basis of two 12,000 kva. electric furnaces operated from hydro-electric power and having six electrodes in line. The closed-roof furnace was used, as SO_2 is given off during this process, and it is essential to remove the fumes by way of a stack, unless the SO_2 is recovered.

Tin and Zinc

Tin Concentrates: Electric smelting of tin concentrates is now being practised in several countries, including France, Spain and the Belgian Congo. The process is one which uses little power owing to the low heat of formation of cassiterite, and in some processes little more than 1,000 kwh. are needed to produce a ton of tin.

Sometimes closed furnaces are used, as in France, where the products are passed through a baghouse to recover fume; but in the Belgian Congo deep charges are used in open furnaces, most of the fume condensing in the upper cold charge, and the smelting is carried out by a cyclic two-stage process, similar in many respects to the Perrin process of ferro-chrome manufacture.

Zinc: The electro-thermal production of zinc—to replace the inefficient horizontal retort system—has engaged the attention of metallurgists for years, and much work has been done in Norway on this process by Harbord and others, many years ago. One of the most difficult problems encountered in electric smelting of zinc is the condensation of the metal. This problem, however, was solved in one way by the St. Joseph Lead Company in America by using a condenser in the form of a U-tube, filled with molten zinc, through which the zinc vapour is passed. They developed a process for smelting by electric resistance, using a preheated sintered zinc ore charged into large vertical retorts. This resistance method of zinc production is what is often called the "dry process," inasmuch as no liquid is made within the furnace proper.

More recently, the New Jersey Zinc Company, who originally developed the vertical retort system of zinc production, have developed a submerged-arc process of extraction which they call the "Sterling" process. They use a 6,000-kva. furnace which is charged with preheated raw materials from overhead charging hoppers, zinc reduction taking place at the interface between the solid charge and the slag. Low-grade iron-containing ores are employed, and pig-iron is produced as a by-product. The condensation problem is solved in this process by using what is called a "splash" condenser, where the molten zinc in the condenser is agitated, or splashed, with paddles, the zinc vapour being scrubbed, so to speak, by molten zinc.

The electric furnace is also used for such processes as the production of nickel anodes from oxidized nickel-matter—the production of a cobalt/copper/iron alloy from cobalt-containing copper converter slags.

The reducing conditions in the electric furnace are so controllable that selective reduction can often be conveniently practised. For instance, if only a low manganese ore is available, that is, ore having a low Mn/Fe ratio, then it can be reduced in the electric furnace to produce a pig-iron, leaving most of the manganese in the slag; in other words, iron is selectively reduced. Then the high-manganese slags can be re-smelted to give a rich ferro-manganese. In Germany manganese metal (96 to 97 per cent. Mn) is made in this way.

Development Possibilities

In the body of the article, sufficient of developments in electric-smelting practice was given to indicate its possibilities not only for the production of strategic alloys in this country, but for assisting materially in the important task for developing Commonwealth resources. Canada, Australia, New Zealand, and even Ceylon have large potential electric power resources. South Africa can produce cheap power from large reserves of very cheap low-grade coals. The Colonial Empire, including East, Central, and West Africa, have hydro-electric potential, some of which is already being developed.

With literally untapped mineral resources, all these territories can play a large part in making up the rapidly dwindling base-metal resources of the older, more exploited, countries.

* Printed in *Iron & Coal Trades Review*. The Author is a director of John Miles & Partners (London) Limited.

AN INTERIM DIVIDEND of 6¼ per cent. on the ordinary capital in respect of the year ending December 31 next has been declared by A. Reyrolle & Company, Limited, manufacturing electrical engineers, etc., of Hebburn (Co. Durham). This compares with a 5 per cent. interim followed by a 7½ per cent. final dividend for 1952.

I.B.F. National Works Visits

For the fourth year running, the Institute of British Foundrymen has arranged a series of works visits open to members from all over the country. This year the East Midlands branch are the hosts, and the nine works in the district are to be visited on October 2. So that the intending participants, as well as other readers, will have some idea of the establishments to be seen, brief descriptions are given in what follows. An effort has been made to record features of the installations of particular interest to foundrymen visitors.

HERBERT MORRIS, LIMITED

The firm of Herbert Morris, Limited, lifting and conveying machinery makers, was founded in London in 1884, and some 16 years later moved to Loughborough. Succeeding years saw the firm expand rapidly, so much so that by 1919 all available space on the original site to the east of the town was occupied. It then became necessary to secure a site alongside what was formerly known as the L.M.S. main line, and by 1924 a large works was in active production. These works have since been twice extended, so that the total area occupied by the firm to-day is about 60 acres. Adjoining the site is a spacious sports ground for the use of the employees. At present there are, therefore, four works, known respectively as the north, south, east and west works, constituting what is probably the largest plant in the world making lifting and conveying machinery exclusively.

The south works is engaged mainly on the production of the firm's smaller products, such as pulley-blocks, roller conveyors, stackers, elevating trucks and winches. Of special interest to visitors is the section where chain is manufactured by electric welding, mainly for use on cranes and pulley-blocks. Such chain must have a high tensile strength as well as great accuracy of link form and pitch, and the methods of securing these qualities are intriguing to engineers and foundrymen alike. The east works comprises the main offices, a centre for training apprentices, tool-room, forge and an extensive electrical section for the manufacture of electric motors, brake magnets, resistances, controllers and various types of special switchgear.

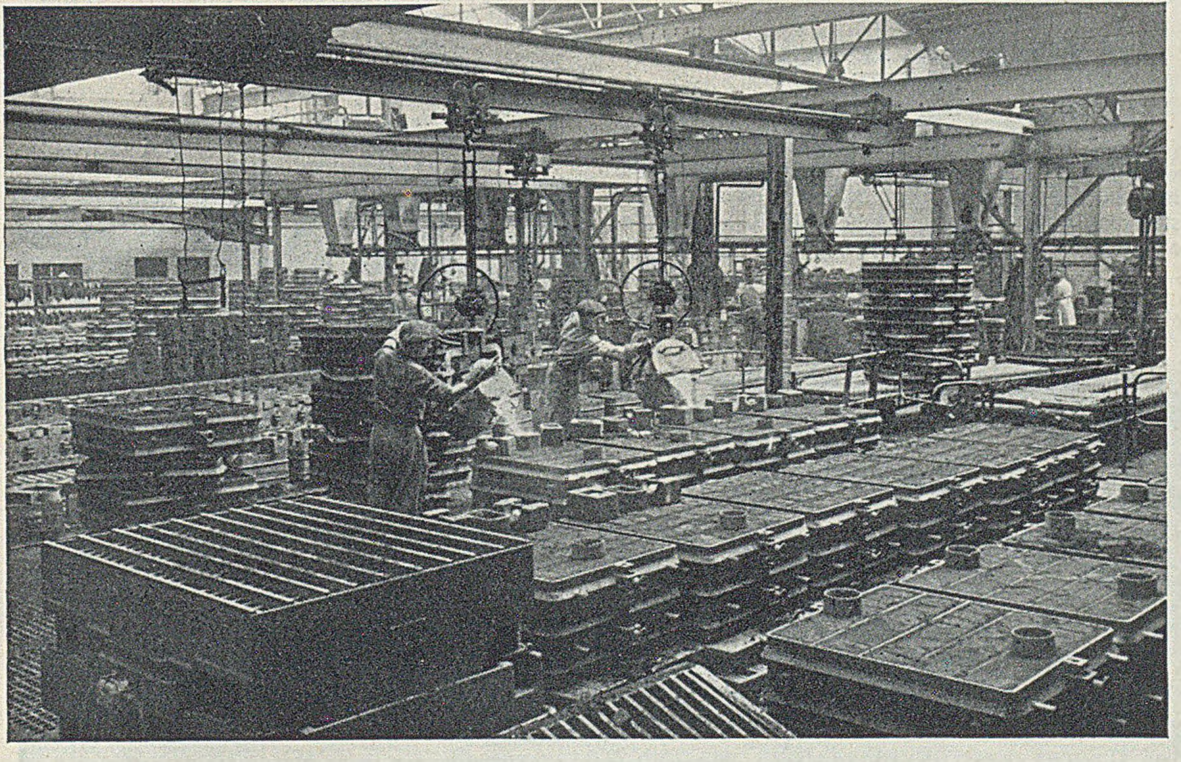


FIG. 1.—*View of the Herbert Morris Mechanized Foundry, with the Moulding Machines in the Background, Pouring from " One-man " Ladles in the Centre and Part of the Knock-out in the Foreground. Of Special Interest is the Travelling Beam from which the Pouring Ladles are suspended.*

I.B.F. National Works Visits

Patternshop and Foundry

Across the way from the main offices is the west works, which for many years served as an erecting shop, but is now an up-to-date patternshop and mechanized foundry (Fig. 1), complete with laboratories. Modern washing facilities, shower-baths and private lockers are installed. Since the firm specialize in the manufacture of equipment for foundry mechanization, it is not surprising that the visitors will find this department of more than passing interest.

There remains the north works—situated a little over a mile from the other three—where are manufactured the firm's heavier and more spectacular products, such as electric overhead cranes, electric jib cranes, mobile cranes, Goliath cranes, and a wide variety of conveyors and elevators. Especially interesting is the equipment for testing electric overhead cranes. Gantries of variable span adjacent to elaborate electrical indicating plant permit cranes of large or small span to be " put through their paces " in conditions of current supply equivalent to that which the cranes will require when actually in use on customers' premises.

Naturally, efficient handling of materials for manufacture has received particular attention and, thanks to a well-thought-out layout of the works as a whole, this has been achieved by remarkably simple means.

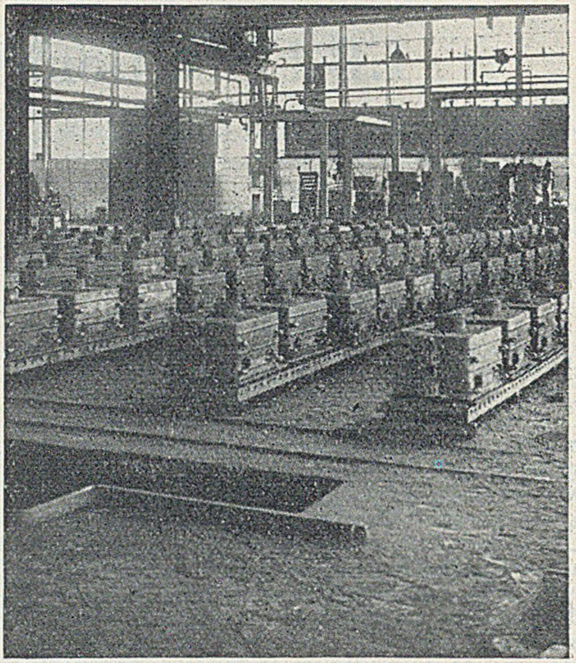


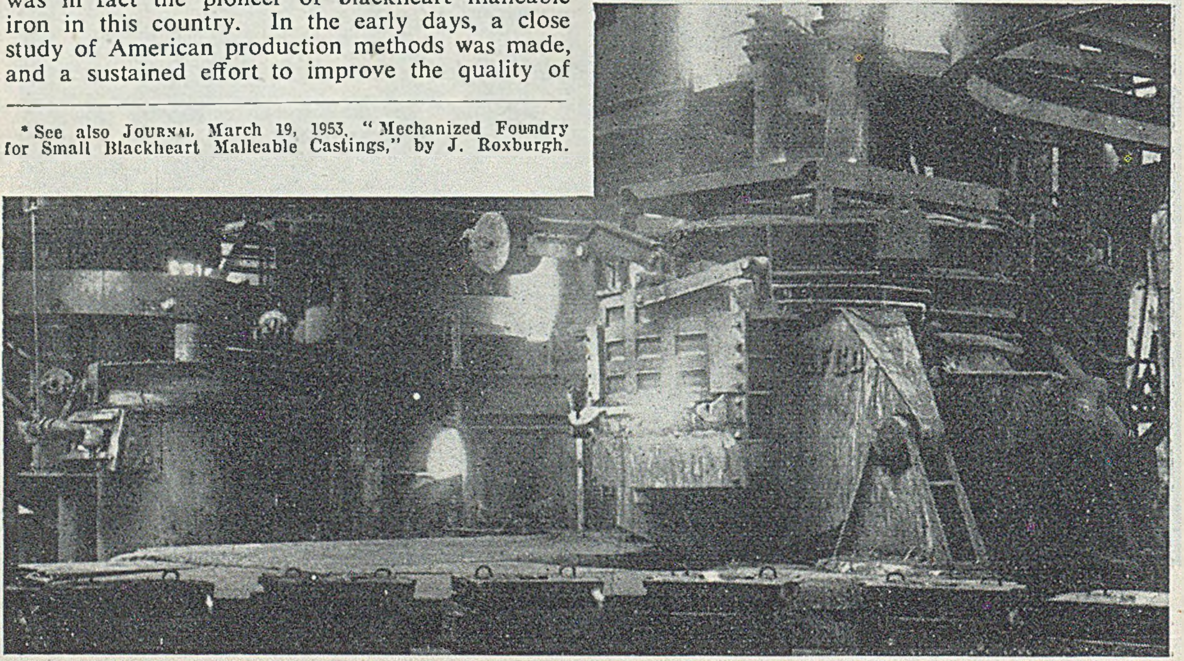
FIG. 2.—*View in the General Foundry of Ley's Malleable Castings Company, Limited, showing the System of Assembling Moulds on Roller Conveyors ready for Pouring.*

LEY'S MALLEABLE CASTINGS COMPANY, LIMITED*

Ley's Malleable Castings Company, Limited, was founded in 1874 by the late Sir Francis Ley, who was in fact the pioneer of blackheart malleable iron in this country. In the early days, a close study of American production methods was made, and a sustained effort to improve the quality of

* See also JOURNAL, March 19, 1953, " Mechanized Foundry for Small Blackheart Malleable Castings," by J. Roxburgh.

FIG. 3.—*Duplex Melting Unit, Cupola/Electric Arc, in Ley's Mechanized Foundry.*



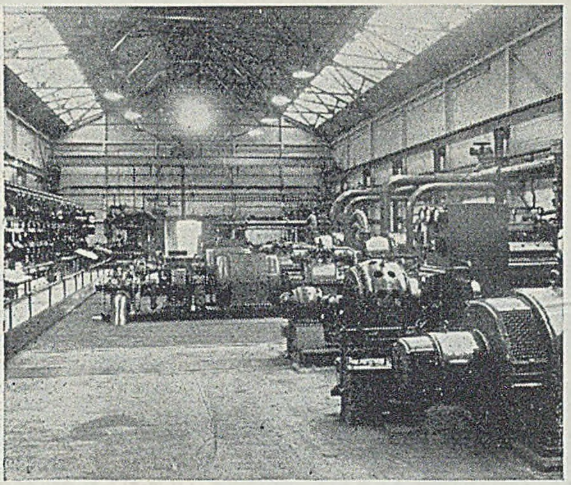


FIG. 4.—*General View of the Power Station at Ley's Malleable, where Waste Heat from the Reverberatory Furnaces is Utilized.*

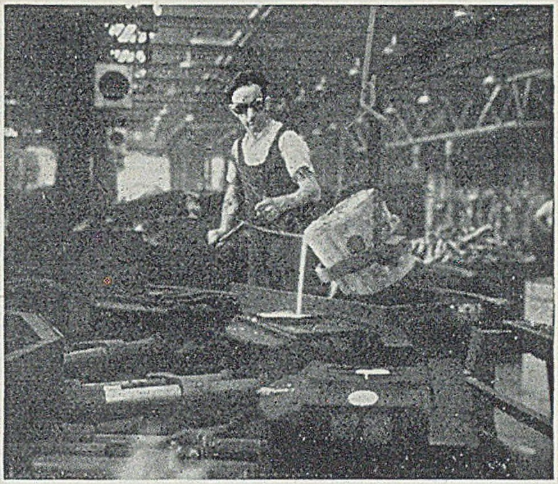


FIG. 5.—*Close-up of Pouring on One of the Rotary Permanent-mould Machines in the Qualcast Foundries.*

the product established a business which has continued to progress to this present day. It is largely due to these efforts that blackheart malleable is now held in high regard as an engineering material as evidenced by its numerous applications where high stress is involved.

Ley's works alongside the Birmingham-Derby railway are readily seen by the visitor approaching from the west. Some idea of the size of these, the largest malleable foundries in the country, is given when considering that an area of some 40 acres is covered by foundry buildings, annealing shops, coremaking and finishing shops. In the general foundries (Fig. 2 shows a part) melting is carried out by furnaces of the reverberatory type fired by pulverized coal. This medium is also used in firing the annealing ovens. Approximately 2,000 people are employed.

Products and Items of Interest

Ley's products, "Black Heart" malleable iron and "Lepaz" pearlitic malleable, by reason of versatile castability, toughness and resistance to impact, confer economy and quality on many automotive, farm-machinery and general-engineering components, and the wide range of castings will be seen in production by the visitors. Also on view will be the operation of a fully-mechanized foundry, duplex melting with cupola and electric furnaces, Fig. 3, and the spectrographic laboratory, where rapid chemical analysis is carried out on bath tests, ensuring correct composition of metal before pouring. Coreblowing will be in operation, and in the patternshops will be seen the actual making of the coreboxes. An interesting point for consideration by the visitors is the conservation of fuel by utilization of waste heat from the reverberatory melting furnaces for the purpose of generating the firm's own electricity, a view of the power station being shown in Fig. 4.

QUALCAST, LIMITED

Qualcast, Limited, was originally founded in Sheffield in 1801 by the great-grandfather of the present chairman and managing director, and moved to Derby in 1849. The firm occupied three separate premises in Derby, whilst being known as the Jobson Foundry Company and the Derwent Foundry Company (1920), Limited, before changing their name to Qualcast, Limited, in 1928 at the formation of a public company, prior to moving to the existing site in Victory Road in 1929. Before the first world war, the company had concentrated on the stove and grate business, but after entering the munition field during that war they have since specialized in high-quality light repetition grey-iron castings. Due to the expansion of the business at Victory Road, new premises have been acquired in Derby for the finished-products division, and the entire Victory Road site is now devoted to foundry production.

Iron Foundries

It is now well known that in 1940 the company acquired the sole rights for Europe of the Eaton permanent-mould process, which has now developed at this site into two separate foundries producing permanent-mould castings, one having ten machines installed, and the other, a more modern plant laid down in 1952, is equipped with seven machines. These two foundries combined have a capacity of over 500 tons of good castings per week. The original plant is served by five 42-in. dia. cupolas and the newer plant relies on two 42-in. cupolas, and in the case of this latter installation, mechanical cupola charging is a noticeable feature. Here the charges are weighed in drop-bottom charging buckets on a travelling scale-car before being hoisted directly into the charging door of the cupola. All pig-irons and shop returns are delivered to the charging bucket by means of a

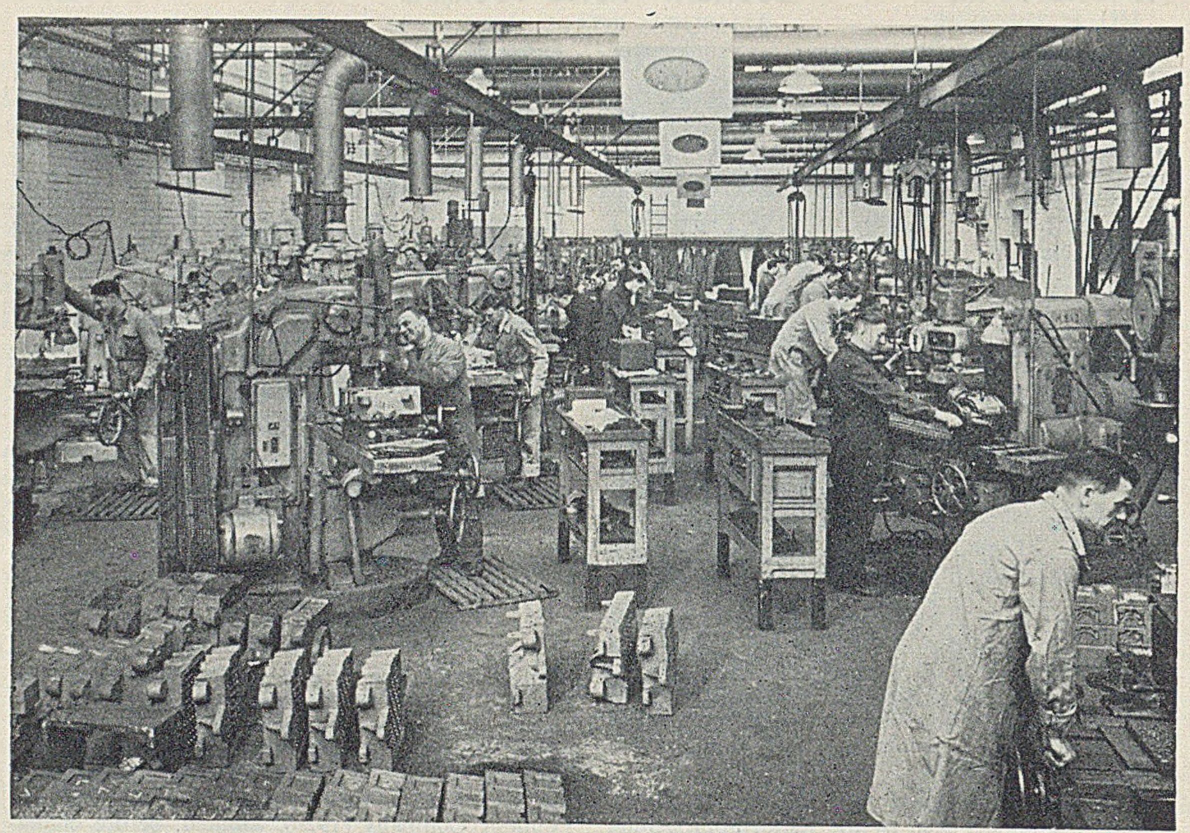


FIG. 6.—*General View of the Die-making Department which serves the Qualcast Permanent-mould Foundries.*

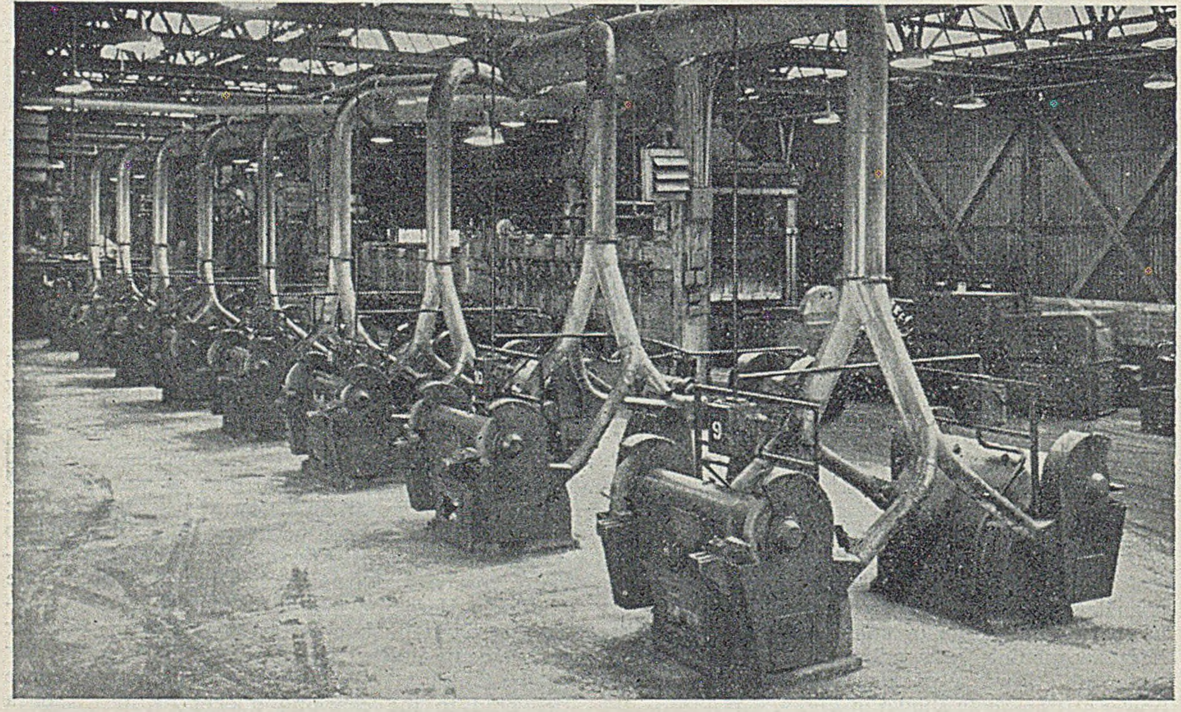


FIG. 7.—*One of the Qualcast Dressing Shops; in the background is a Continuous Annealing Furnace.*

5-ton magnet crane, which is also used for discharging incoming supplies arriving by road and rail. These two foundries are served by an extremely efficient die-making department, which is very well equipped with modern plant.

There is also the orthodox grey-iron foundry, specializing in high-duty castings for the automobile, refrigeration and electrical industries, using conventional but highly-developed methods of moulding, core-making, etc. This foundry is served by two 56-in. dia. cupolas and one 36-in. cupola, and deals with nearly 300 tons of good castings per week of an average weight of 3 lb. This section is served by a coreshop in which the visitors will be interested to note that hand coremaking has been almost entirely eliminated.

Other Activities

Since 1935, a steel foundry has been developed on this site, which is at present served by a 30-cwt. Stobie direct-arc furnace, which will shortly be supplemented by a 3-ton E.F. Company direct arc furnace of the latest design, for the production of heat-resistant and abrasive-resistant castings, of which the present output is approximately 50 tons per week. The illustrations of the Qualcast works accompanying this article (Figs. 5, 6, and 7) show respectively a portion of a rotary die-casting machine, dies being made, and one of the large dressing shops.

The layman visitor who relies on national advertising for his general knowledge will be surprised that there is no semblance of lawn-mower production at these works, which really consist of four completely self-contained foundries forming part of the thirteen works/divisions comprising the Qualcast Group.

BAMFORDS, LIMITED

This is one of the few remaining agricultural engineering family businesses in the country, and has been built up on the south side of the market town of Uttoxeter by four generations of the Bamford family. Established 78 yrs. ago by Mr. Henry Bamford and his eldest son, Mr. Samuel B. Bamford, the business has been progressively built up until now the name "Bamford" is a household word amongst agriculturists, and their products are sent to practically every country in the world. The present directors are H. B. and C. J. Bamford of the third generation and H. V., R. H., J. G. and R. C. Bamford of the fourth generation of the family. The business was converted into a limited liability company in 1916, but this did not involve any change in the management. The relations between the directors, staff and workpeople have always been of an intimate and cordial character and many of the employees have been with the company for well over half a century and this co-operation has achieved remarkable results in the way of production. An example of this was that despite the depletion of personnel during the war, the company maintained the production of agricultural machinery so vital to the nation at that time, and also made a notable contribution to the war effort by making over a million gauges and other essential parts calling for high engineering skill and accuracy.

Foundry

An ever-present requirement of the Bamford Foundry is flexibility to meet the changing requirements of agricultural-implement design as well as the seasonal nature of some of the production. Thus, mechanization is on a limited scale, though there is a modern Pneulec sand-preparing plant; an

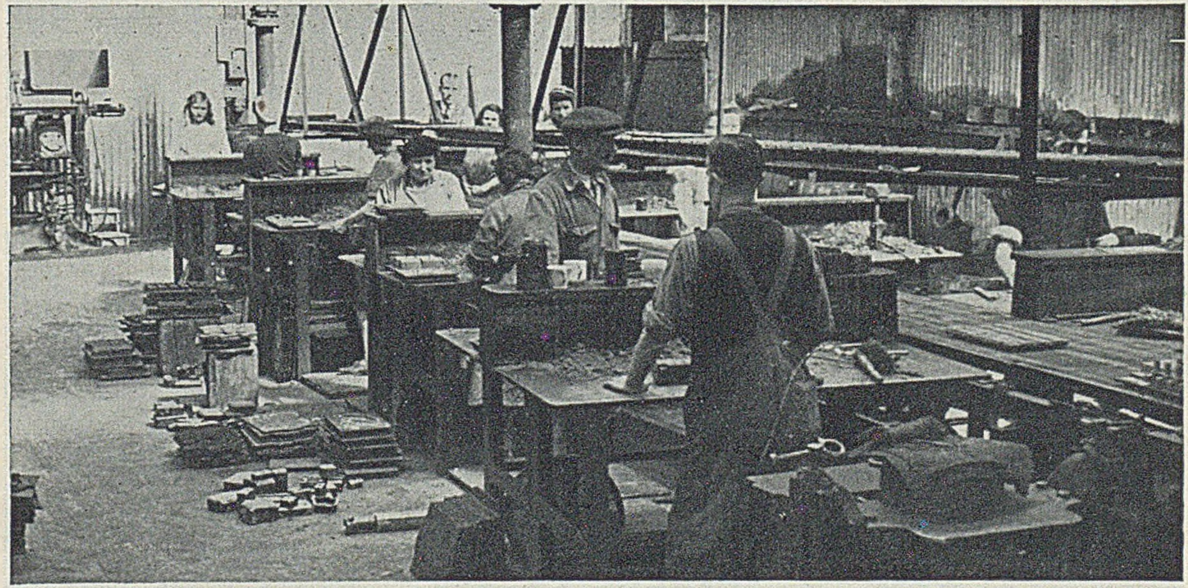


FIG. 8.—*Coremaking on both Sides of a Moving Steel-band Conveyor at the Foundry of Bamfords, Limited, Uttoxeter.*

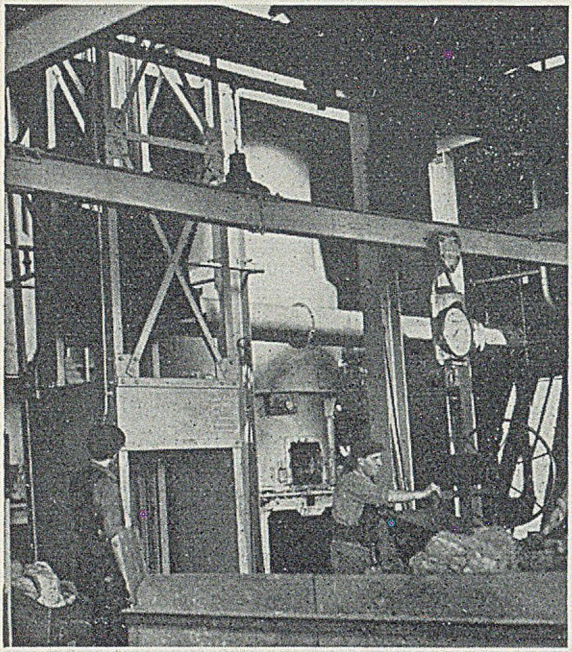


FIG. 9.—*Part of the Melting Plant at Bamfords, Limited, showing the Automatic Vertical Charging Hoist, placed between Two Cupolas.*

August's Mill for core-sand; a battery of moulding machines and Royer machines for reconditioning floor sand. A steel-band conveyor serves the core-making benches (Fig. 8) and drying is carried out in an Acme vertical continuous stove.

The melting shop* is equipped with four modern cupolas, two of $7\frac{1}{2}$ tons per hr. capacity, one of three and one of two tons. These are served by a mobile vertical skip hoist (Fig. 9). The stockyard is well-laid out, charges being collected from the bins in a skip carried from a monorail. It is expected that foundrymen visitors will be particularly interested in this modern cupola layout, which requires only three men for operation.

The fettling shop is well separated from the foundry and movement is progressive to the dispatch bay. Both a rotary table and drum-type shot blast plants are employed. In one corner of the foundry is a non-ferrous section where bearing bushes forms the staple production.

Welfare facilities are catered for by the provision of a well-appointed canteen, whilst on the sports and social side there is a works' club for indoor recreations, and a magnificent sports ground at Oldfields, laid out by the late Mr. John Bamford, which has been the venue of many representative cricket matches, including those of the Australians and other touring teams.

* See also "A Modern Melting Plant," JOURNAL October 27, 1949.

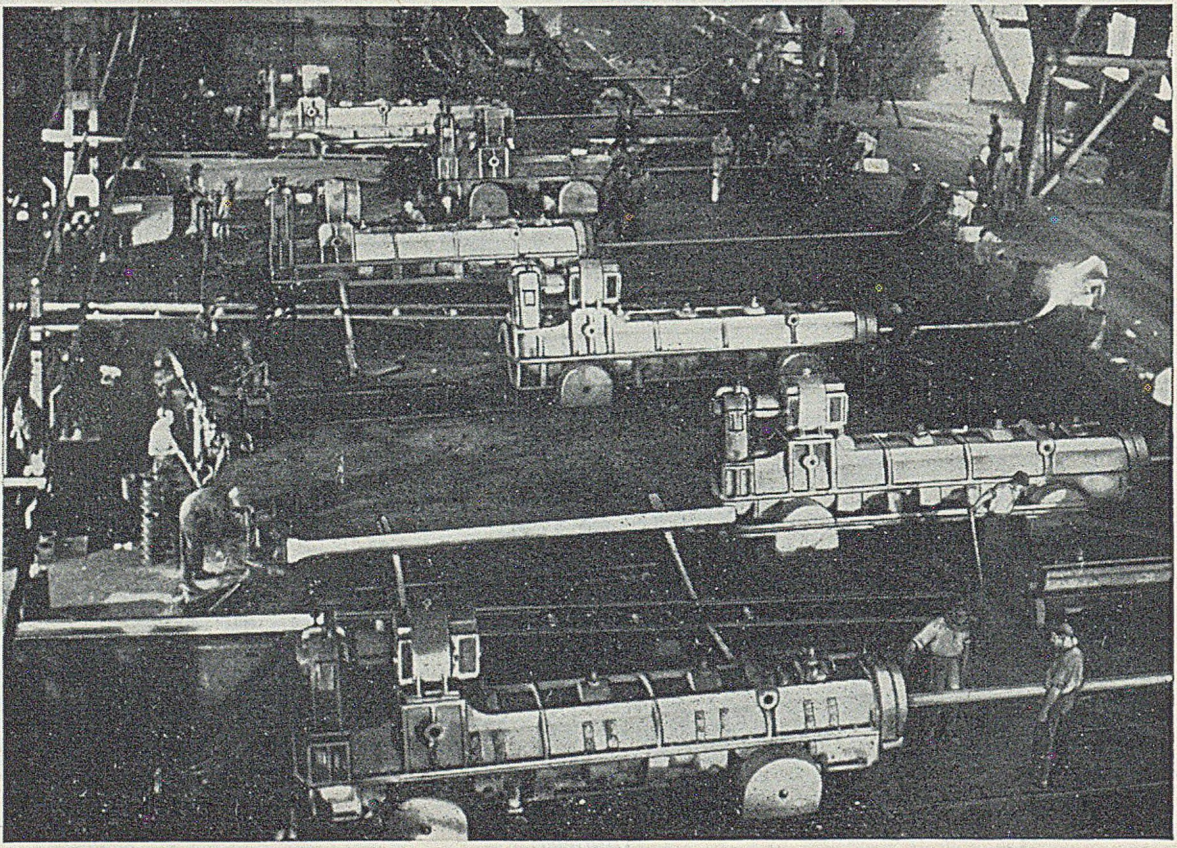


FIG. 10.—*Section of One of the Spun Iron Pipe Plants of Stanton Ironworks Company, Ltd., Near Nottingham.*

In this well equipped and up-to-date works, now covering an area of 20 acres, Bamfords have specialized chiefly on harvesting and barn machinery, whilst some years ago they equipped a special section of the factory for manufacturing petrol and Diesel engines for farm and industrial use. Among hundreds of other prominent awards, on eight occasions they have been awarded the silver medal of the Royal Agricultural Society of England for equipment of exceptional merit.

STANTON IRONWORKS COMPANY, LIMITED

Stanton Works

At Stanton Ironworks Company, Limited, Nr. Nottingham, the visiting foundrymen will see the "spun plants" where centrifugal casting is carried out on a large scale. Three plants are in operation, producing pipes for gas and water undertakings, in all sizes up to and including 27-in. dia. and in 12- and 18-ft. lengths. The pipes are spun in water-cooled metal moulds, a view of one of the batteries of machines being shown in Fig. 10. A total of more than 1,000 men are employed on these three plants.

Also to be inspected is the Company's mechanized (Erewash) foundry which employs some 300 personnel, who operate two separate sections under the one roof. One section produces component parts for the Stanton "Screwed-Gland" and "Bolted-Gland" flexible joints, and the other section is a new plant producing pipe "specials" up to 27 in. dia. and also tunnel segments. All moulds are made on turnover or down-draw machines and are rammed by impellor-type machines.

Holwell Works

A separate party of Institute members will travel to Melton Mowbray to see the Holwell works of Stanton Ironworks Company, Limited. Approximately 550 men are employed in the foundry section of these works, which comprises fully-mechanized foundries and jobbing shops. The former comprise a large continuous-casting plant (Fig. 11), where about 270 men are engaged, principally, on production of pipe "specials" up to 9-in. dia. Other products include railway chairs, base-plates and wagon brake-blocks for British Railways, and component parts for use with the Stanton "Screwed-Gland" and "Bolted-Gland" flexible joints. Another foundry is engaged solely in the production of ingot moulds. Here, the moulds and cores are rammed by jolter machine, and sand-preparation plant is installed. The jobbing foundries are engaged on making pipe "specials," ingot-mould bottom plates, and sundry castings, principally for maintenance purposes.

(To be continued)

11th-hour Applications. The closing date for receipt of applications for participation in the fourth National Annual Works Visits Day of the Institute was Tuesday, September 1st, but anyone who still wishes to go and has not yet applied, is requested to communicate with the secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3, immediately, as there may be a few vacancies left for some of the visits.

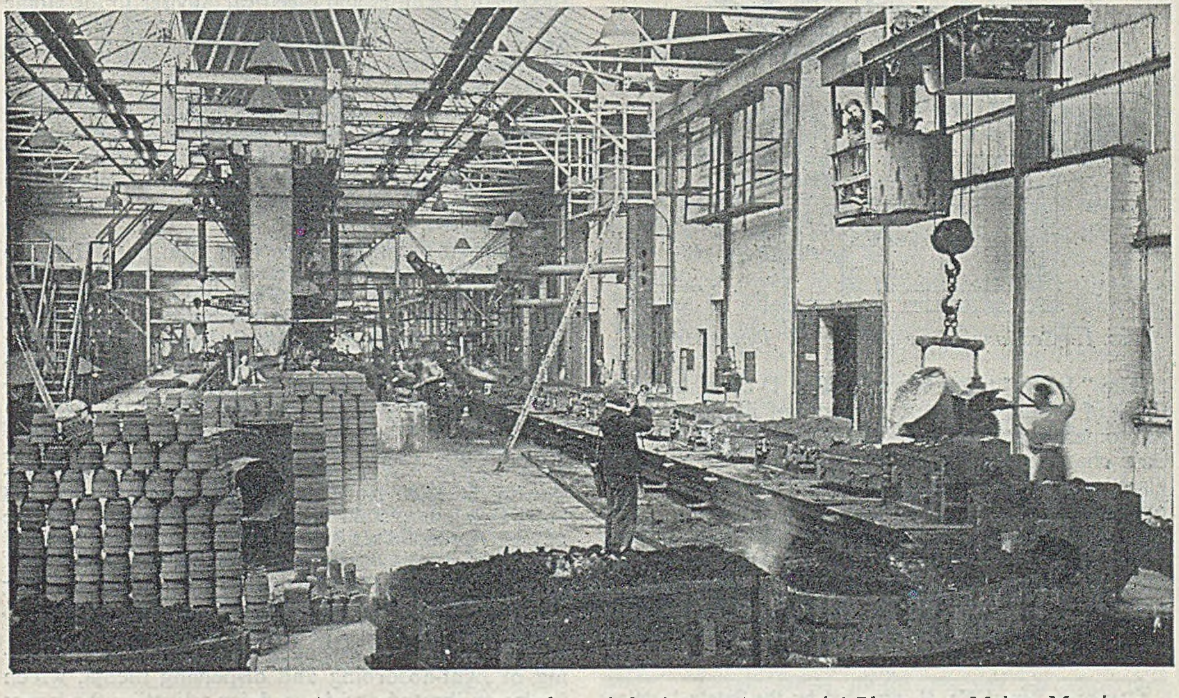


FIG. 11.—*View in the Holwell Continuous Casting Shop of the Stanton Ironworks' Plant, near Melton Mowbray.*

Assessment of Dust Concentrations

Sampling of airborne dusts is a necessary part of the routine control and suppression of dust and of the collection of data for correlation with the incidence of pneumoconiosis. Instruments designed to make assessments of dust concentrations have so far depended on the use of relatively few scientific principles, such as settling, filtration, washing, impingement, thermal or electric precipitation, resistance to fluid flow of a packed bed of the dust, obscuration or scattering of light by the suspended dust particles, etc.

Assessments made by these instruments are on the basis of mass, on number, or on surface area of the particles, and may be made *in situ* in the dusty environment or, more usually, in the laboratory at a later stage. Instruments differ, too, in that some take a long-term continuous sample to provide an average result for the period of sampling, while others take a series of snap samples which indicate the conditions at particular instants only.

A recent report* prepared by Mr. G. Broomhead and Mr. J. T. Burdekin deals with an investigation into the performance of the "Leitz" tyndallometer, an instrument designed to give numerous instantaneous assessments of dust cloud concentrations from measurements made of the amount of light scattered by the airborne particles when the cloud is illuminated by a standardized light source.

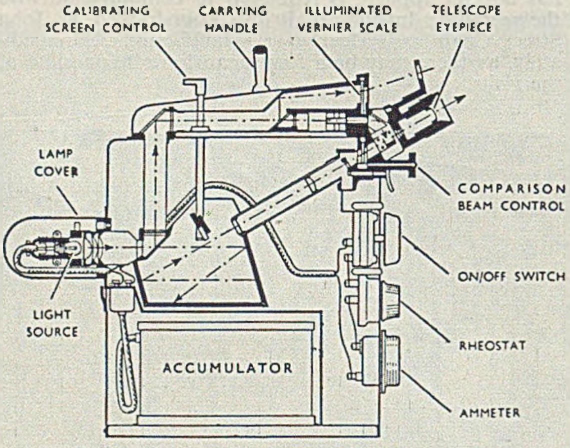


FIG. 1.—*Sectional View of "Leitz" Tyndallometer.*

The "Leitz" tyndallometer (Fig. 1) consists essentially of a dust chamber, a means of illumination, a photometer head, and an observation telescope. The dust chamber, which is lined internally with black glass, can be partitioned off from the surroundings by means of two sliding panels at the side. The pencil of light enters the chamber through a small window in the front wall, which is at the same time the light divider for the photometer. Opposite this window the observation telescope projects into the chamber. In the chamber, a calibrating screen can be switched in and out of the pencil of light, consisting of light-absorbing and dispersing media, which is also calibrated and is used for adjusting the lamp; during the measurement it is switched out.

(Continued foot of next col.)

* Research Report No. 61, prepared by the Safety in Mines Research Establishment and published by the Ministry of Fuel and Power. (Price 2s. 6d.)

Personal

DR. R. GENDERS has been appointed metallurgical consultant to the Vanadium Corporation of America.

MR. P. C. N. PICKWORTH, chief engineer of B. & S. Massey, engineers, has been appointed a director of the company.

DR. S. F. DOREY, C.B.E., D.SC., F.R.S., has been nominated by the Council as president of the Institute of Metals.

MR. CECIL F. HURST, technical director of Samuel Osborn & Company, suppliers of steel, castings, and tools, has been appointed deputy-chairman of the company.

After 39 years' service in the gas industry, MR. J. PARKER, of Leamington, has retired from the post of Divisional Coke Officer of the West Midlands Gas Board.

MR. G. PICKERING, who has been senior engineer surveyor at Liverpool since 1948, has been appointed principal surveyor to Lloyd's Register at the port, in succession to the late Mr. T. Pratt.

MR. P. H. MUIRHEAD, general manager of the Elswick and Scotswood works of Vickers'Armstrongs, Limited, Newcastle-upon-Tyne, has left for a month's business tour of Canada and the United States.

SIR IAN BOLTON, who has been a part-time member of the British Transport Commission since 1947, has been reappointed for a further three years from October 1. Sir Ian is a director of the Coltness Iron Company, Limited.

THE RT. HON. R. R. STOKES, M.C., M.P., managing director of Ransomes & Rapier, Limited, and Cochran & Company, of Annan, both manufacturing engineers, is sailing from Southampton in the Queen Mary to-day on a business tour in Canada.

MR. F. H. MANN, Deputy Senior Electrical Inspector of Factories, has been appointed Senior Electrical Inspector of Factories and Electrical Adviser to the Home Office as from October 1. He will succeed Mr. H. W. Swann, who is retiring from the position at the end of this month.

MR. ROBERT L. WALSH, a member of the Cutlery Wages Council, has been elected Sheffield's 318th Master Cutler, in succession to Sir Harold West, of Newton Chambers. Mr. Walsh, who is 51, is a member of the seventh generation of a family of Sheffield cutlers, and his great-grandfather, Thomas Champion, was Master Cutler in 1882.

ASSISTANT SECRETARY since 1939, MR. E. C. HAPPOLD has now been appointed secretary of the Engineering and Allied Employers' National Federation. He joined the staff of the Federation in 1936 and has been acting secretary since the death of Mr. A. C. Law. Before joining the Engineering and Allied Employers' National Federation, he occupied a number of engineering and production posts with Imperial Chemical Industries, Limited.

SIR ARCHIBALD FORBES, chairman of the Iron and Steel Board, commences a four-day visit to Luxemburg to-day. A spokesman of the British delegation to the High Authority of the European Coal and Steel Community said on Wednesday that the purpose of Sir Archibald's visit would be to make "formal and social" calls on M. Jean Monnet, the president of the High Authority, and other officials of the six-nation community.

Heat-treatment of Metal and its Fire Hazards*

By R. W. Oxenbury, F.C.I.I., A.I.A.S.

Fire and Explosion Hazards

When considering the fire and explosion hazards of heat-treatment processes, first consideration is the building itself in which the processes are carried on. The ideal is a lofty structure of incombustible construction, preferably built of brick or concrete with a metal or asbestos roof on a steel framework and a concrete floor. Many large firms do their hardening and quenching in a separate building, but though this arrangement has everything to commend it, it is not always practicable. In smaller firms, hardening is frequently done in the same shop as the metal-working processes, and tool-rooms have their own muffles and quenching baths.

Although high temperatures are attained in furnaces the latter are so well constructed and insulated that there is very little heat-loss through the walls, roof, and hearth, and the risk of fire through contact with combustible material is not great. The flue, however, needs to be fixed so that there is no combustible material within a distance of 3 or 4 ft. It should be constructed of substantial materials, and, especially where gas or oil fuel is used, so arranged that no down-draughts can cause inflammable waste gases to accumulate. The flue needs regular cleaning, and should be provided with a door for this purpose. An explosion door is also necessary, and the flue dampers should be arranged so that they always remain partially open. The flue must pass right through the wall or roof of the building, and should not be allowed to get into a poor state of repair, or sparks and waste combustion products might find their way through the damaged parts and ignite roof timbers or other combustible material in the vicinity.

Quenching Tanks

Because of the need for rapid quenching, it is usual to find the oil bath very close to the furnace, so that the hot steel can be plunged into the oil with the minimum of delay. Particular care should be exercised with oil baths to see that the oil is not made so hot as to vaporize. The continual and rapid quenching of steel articles in an oil bath may raise its temperature until a point is reached when the vaporized oil is ignited by a piece of hot steel. This is a frequent cause of fires in hardening shops, especially where there are low timber roof-trusses a few feet from the quenching bath. This risk can be minimized by the installation of a cooling system in which cold water circulates through coils in the oil bath itself, or the oil can be pumped through an independent cooling system. Oils having fairly low flash-points should not be used for quenching, and neither should oils causing abnormal sedimentation, as in time a deposit of heavy sludge will settle on the cooling coils in the tank, thereby reducing their effectiveness. When not in use, oil tanks should be covered with metal lids.

Oil Storage

When oil fuel is used to heat a furnace, particular care and attention is needed in the storage and heating arrangements. The oil is usually stored in a steel tank, the best position being underground in an open yard. If the tank is inside the building it should be buried underground in the lowest basement or cellar and covered with concrete. Any storage tank above ground level should be in a chamber of brick or concrete provided with a steel door and a raised sill of such a height that, if the tank should fracture, all the oil would be contained in the chamber. Oil-storage tanks on a roof are obviously undesirable, but where such a location is necessary the best position is on a flat roof of concrete. A catch-pit made of incombustible material built around the oil tank is always desirable, but, where the roof is not constructed of concrete or hollow blocks, a catch-pit, big enough to contain all the oil, is essential.

The storage tank is provided with a fill-pipe terminating in the open yard and a vent pipe so arranged that oil vapour does not enter doors or windows or come into contact with chimneys. A sludge cock is fitted to draw off any sediment.

The service tank is usually found near the furnace itself, and can be filled from the storage tank by gravity feed, or by hand or electric pump. There should be an overflow pipe to return any oil to the storage tank or to a safe place in the open. Both service and storage tanks should be fitted with fire valves fixed close to the tank and arranged to close automatically in the event of fire. A fusible link should be set over each firing place so that it melts at a temperature not exceeding 100 deg. C. The fusing of the link by abnormal heat will close the fire valve and stop the flow of oil to the burners. It cannot be emphasized too strongly that strict cleanliness is essential, particularly in the burners, oil strainers, blowers, and flues. Testing by a competent engineer should be carried out at least twice a year.

First Aid

The best fire appliances for first-aid work are buckets of sand and extinguishers of foam, carbon dioxide, or carbon tetrachloride. Dry-powder extinguishers are also most effective, especially when vapour from oil-quenching tanks ignites, provided that they are brought into use immediately. Large tanks might require an automatic installation of foam or carbon dioxide or the type giving a mist or spray of water which forms an

* This extract is Part V of a Paper read before the Chartered Insurance Institute.

Heat-treatment of Metal and its Fire Hazards

emulsion with the surface layer of oil. It is unusual to find oil-quenching tanks so protected, however, so that it is not necessary to go into any details here.

Fire risk from the heating of the actual metal in the furnace can arise only in the treatment of magnesium and its alloys. When treating this metal it is essential to keep the furnace free from scale, and the magnesium castings should be clean and free from grinding dust and sawings. If the metal does ignite, the fire may be extinguished either by blowing into the furnace a special free-running powder especially designed for smothering fires, or by pumping in Phosphon 6, a liquid with a high flash-point, without opening the furnace doors. Dense fumes will be given off when the liquid vaporizes and will extinguish the fire. A slight pressure will build up inside the furnace and tend to escape through the furnace openings, thus preventing air from entering. The furnace should not be opened up until it is quite cool.

Salt Baths

Salt baths, particularly those in which sodium nitrite and nitrates of soda and potash are used, need very careful attention. These salts are powerful oxidizing substances and should be kept away from all combustible matter. For this reason, salt baths should if possible be located in a separate building of substantial and incombustible construction. A brickwork sump built around the bath is desirable, so that if the bath should fracture the sump will hold all the molten salts. Alternatively, a catch-pit in the ground underneath the bath will serve the same purpose. When not in use, the bath should be provided with a close-fitting metal cover.

It is necessary to melt the salts slowly and uniformly so as to prevent local overheating. Water must not be allowed to come into contact with the molten salts, or an explosion might occur and scatter the salts over a wide area, so igniting combustible material. All articles for immersion in the bath must be free from water, oil, and grease. The best substance for extinguishing salt-bath fires is clean, dry sand. On no account should the same bath be used for different types of salt. Cyanide salts in contact with nitrates may when hot produce a dangerous explosion.

The special plants for making controlled atmospheres are usually so well constructed that the risk of fire or explosion is not great. Careful handling of steel cylinders of compressed or liquid gases is necessary. Particular care must, however, be exercised when charcoal gas is used, as it will form an explosive mixture with air. All air in the furnace must be driven out before heating begins, or a violent explosion may result.

General Conditions

If the risk of fire in any industry is to be kept to a minimum, cleanliness and good supervision are essential. This applies no less to heat-treatment processes than to any others, and regular testing, cleaning, and maintenance of plant should be the rule in every factory and workshop. That important strides are still being made is shown by the fact that controlled atmospheres for protecting metal during heating have become general only during the last 20 yrs. One of the latest developments is high-frequency heating, and the time may not be far distant when the use of atomic energy will alter all present ideas on the subject. In the meantime it is necessary to keep in touch with the most up-to-date methods of fire extinguishment, and it is encouraging to know that constant research is being carried out by the fire-insurance companies and other bodies interested in fire prevention.

New Catalogues

Precision Castings. A four-page leaflet issued by Deloro Stellite Limited, Highlands Road, Shirley, Birmingham, deals with the development of components using the precision-investment casting process and Stellite as the alloy melted. It so happens that this material lends itself particularly well to such manufacturing methods.

Light-alloy Sand Castings and Die-castings. H. J. Maybrey and Company, Limited, of Worsley Bridge Road, London, S.E.26, prepared for distribution from their stand at Olympia a folder carrying impressive pictures taken from the wide range of castings which they make both by the sand and die-casting processes. Space has been allocated to the listing of the specifications normally used, the minimum mechanical properties given and the purposes for which the alloys are employed.

Sawdust Removal. A four-page leaflet from the Standard and Pochin Bros., Limited, of Evington Valley Road, Leicester deals not only with the removal of sawdust from pattern making machinery, but takes the subject further to include its use as a fuel for boilers or destructors. It is mechanically stoked and the apparatus can be fixed to existing boilers. This leaflet is available to readers on writing to Leicester and in addition several catalogues are issued by the firm, dealing with various phases of ventilating, by means of fans and roofing devices.

Investment Materials. The Monsanto Chemicals Limited, Victoria Station House, London, S.W.1, have just issued a very well produced brochure carrying the caption "Monsanto Silesters." By a series of illustrations it shows the making by the investment process of a casting and modification for the making of piece moulds. The final section is devoted to permanent ceramic moulds—a subject which has in recent times received renewed interest. This catalogue is available to readers on writing to Victoria Station House.

Hydraulic Loaders. E. Boydell and Company, Limited, Elsinore Road, Old Trafford, Manchester, 16, have sent us a catalogue covering the Muir-Hill LH/1 loader. Generally speaking, this machine is a small, petrol-driven pneumatic-tyred truck carrying before it a hydraulically operated bucket which is designed to fill itself at floor level with such material as sand or rubbish and then in a new position completely empty itself. For providing a system of shifting material about a foundry, this type of machine has much to commend it. The catalogue is available to readers on writing to Old Trafford.

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

By D. Fleming

(*Continued from page* 357)

Zone III Reactions

Fig. 12 shows the variation with temperature of the free-energy change accompanying the conversion of one gram. molecule of oxygen, at one-atmosphere pressure, into the appropriate quantity of oxide. It also shows the $CO:CO_2$ ratio in equilibrium with the element and its oxide at a given temperature[6]. The curves for the oxides of carbon, iron, silicon, manganese and phosphorus have been reproduced. As an example of the use of these curves, the reaction $2FeO \rightarrow 2Fe + O_2$ at 1,190 deg. C. can be taken, when it will be found that the value of the $CO:CO_2$ ratio, in equilibrium with both oxide and metal at this temperature, lies between 1:1 and 10:1 and, by interpolation on a logarithmic basis, the actual value is found to be $CO:CO_2 =$ 2.7:1. Values of $CO:CO_2$ greater than 2.7 would thus cause reduction of the oxide, whilst those of less than 2.7 would cause oxidation of further iron. It also becomes immediately apparent that, with ratios of $CO:CO_2$ of 10:1 or over, FeO would be reduced rather than Fe oxidized at temperatures as high even as 1,800 deg. C. Now it is known that $CO:CO_2$ ratios much higher than these can be achieved in this area of the cupola, so that reduction will take place, and, as higher temperatures will increase the $CO:CO_2$ ratio faster than they increase the ratio required for reduction, the higher the temperature, the greater the energy in favour of reduction will become, and the more efficient the process.

One can similarly see that the reduction of manganese $2\ MnO \rightarrow 2Mn + O_2$ is more difficult than that of iron, for, at 1,800 deg. C., this reaction would not take place by reduction by CO, *i.e.*:—

$$\begin{array}{ll} & 2\ MnO \rightarrow 2\ Mn + O_2 \\ \text{Add} & O_2 + 2CO \rightarrow 2CO_2 \\ \hline & 2\ MnO + 2CO \rightarrow 2Mn + 2CO_2 \end{array}$$

even at a $CO:CO_2$ ratio of 10^3:1, in fact, further oxidation would occur at these values. With a $CO:CO_2$ ratio of 10^4:1, however, reduction would occur at temperatures above some 1,360 deg. C., and at the same order of $CO:CO_2$ ratio, reduction by the complementary oxidation of carbon, $2C + O_2 \rightarrow 2CO$, would become possible at a temperature of about 1,420 deg. C., *viz.*:—

$$\begin{array}{ll} & 2\ MnO \rightarrow 2\ Mn + O_2 \\ \text{Add} & O_2 + 2C \rightarrow 2CO \\ \hline & 2\ MnO + 2C \rightarrow 2\ Mn + 2CO \end{array}$$

It can also be seen that the reduction of silicon from silica, $SiO_2 \rightarrow Si + O_2$ is possible, with the conversion of carbon to carbon monoxide $2C + O_2 \rightarrow 2CO$, at temperatures above 1,540 deg. C. and $CO:CO_2$ ratios of approximately $(1.8 \times 10^4):1$, whereas reduction by the complementary oxidation of CO to CO_2 would require a $CO:CO_2$ ratio of over $10^5:1$ at 1,300 deg. C., or $10^4:1$ at 1,620 deg. C., etc., the necessary $CO:CO_2$ ratio diminishing with increasing temperature, whilst, as is already known, the achievable $CO:CO_2$ ratio increases with temperature.

Summary of Hearth Reactions

Summarizing the reactions for iron, manganese, and silicon, in the cupola hearth, it is found that all three can be reducing under possible cupola conditions; that the reduction becomes progres-

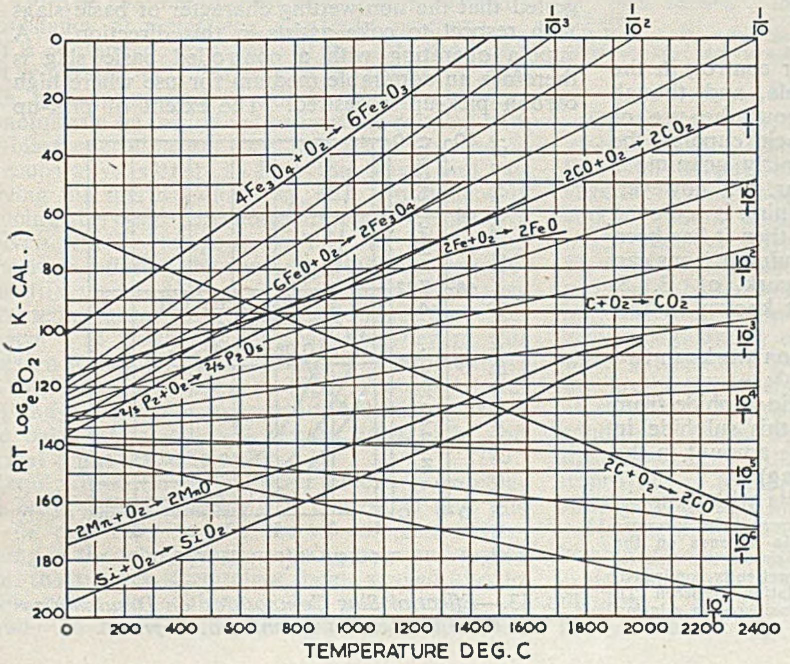


FIG. 12.—*Variation with Temperature of the Free-energy Change accompanying the Conversion of One Gram. Molecule of Oxygen at One Atmosphere into Various Oxides.*

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

Reactions in the Cupola

sively more difficult, in the order in which they are named, and that the degree of reduction is favoured by increasing hearth temperatures. Now, in the cupola, metal, slag, and hearth temperatures increase with increasing carbon : iron ratios, which also increase the $CO:CO_2$ ratio in the effluent gases, as has been shown earlier, so that the degree to which hearth reduction offsets previous oxidation (which has also been shown to increase in the other cupola zones as the $CO:CO_2$ ratio of the effluent gases decreases) will vary in such a way that $CO:CO_2$ ratio in the effluent gases* can be used as an index of melting losses, and metallurgical, as opposed to thermal, efficiency—high $CO:CO_2$ ratios meaning low melting loss, and *vice versa*, whilst, as is well known, overall thermal efficiency varies in just the opposite direction.

Even for the case of fairly tolerant conditions, this should give pause to those whose fetish is lower and lower coke consumption, in case the economic losses occurring in melting overtake the saving gained by coke reduction, but the case can be taken further than this in certain conditions where the output required is a soft grey iron.

The conditions cited are those where the economic costs of a mixture based on cast-iron scrap, steel scrap, returns, and ferro-alloys are well below the cost of a conventional mixture. Why in these cases is pig-iron used? Is it not fundamentally as a source of high-carbon, low-sulphur material to offset the limitations of the conventional acid cupola, in which the soft irons tend to lose carbon and gain sulphur? If melting losses could be minimized, and simultaneously carbon and sulphur could be controlled, would not an entirely different approach be made to the whole subject of economic cupola operation?

Desulphurization

Little can be done about sulphur control, in the true sense, in an acid-lined cupola, and though various opinions are expressed about the use of fairly high limestone additions in acid cupolas, the only effect on which opinion is fairly unanimous is a decided increase in lining wear. If, however, the neutralizing effect of the acid lining is removed and truly basic slags are operated, then it has been shown by many workers that low-sulphur irons can be produced consistently; the work of E. S. Renshaw[8] being, perhaps, the best known in this country.

The mechanism of desulphurization works in two ways (Rocca, Grant and Chipman)[9]:—

(i) The slag dissolves the metallic sulphide from the metal until the amount of this sulphide in the slag is in equilibrium with the amount in the metal, *e.g.*, $FeS(metal) \rightleftharpoons FeS(slag)$.

(ii) The metallic sulphide reacts with lime in the slag to produce calcium sulphide and iron oxide, *e.g.*, $FeS + CaO \rightleftharpoons FeO + CaS$.

Stage (ii) can only operate effectively in slags having excess lime (CaO) available and in which only low percentages of iron oxide already exist. Fig. 13, from data of Rocca, Grant and Chipman, shows this admirably.

It has also been shown that, for consistent practical results, an adequate slag depth and volume are required, and, obviously, consistent temperature, fluidity, and slag composition and depth, are required. Some technicians say that high temperature is not necessary in itself, and others comment on greater efficiency with high rather than low coke-ratios, and it is felt that both these factors are, in fact, linked with the need for low FeO content in the slag which Fig. 13 shows is required, and which, as previously noted, is favoured by high temperature resulting from high coke-ratios. Most work has been done in basic-lined cupolas, but it is suggested that the most economic approach to the problem, and one which removes the uncertainty caused by variable interference of material from the lining, is the water-cooled cupola.

The subject of desulphurization cannot be left without reference to work[10] showing that additions of calcium carbide to the bed coke, and/or charge coke, materially assist in the production of iron of low-sulphur content from basically-operated cupolas.

Carbon Control

Turning now to carbon control, it has also been shown by various authorities [8, 10, 11, 12, 13] using basic cupolas that higher carbon pick-up can be obtained more easily in cupolas operating with basic slags, and it is believed that this is due to the more rapid removal of the ash network, which is acid in character, by the basic slag, thus keeping the carbon surface active and available. It is also suggested that the non-wetting character of basic slags with respect to coke assists in this direction. A cupola operating with a controlled basic slag is therefore an admirable medium for use where high carbon pick-up is desired. The extent of pick-up

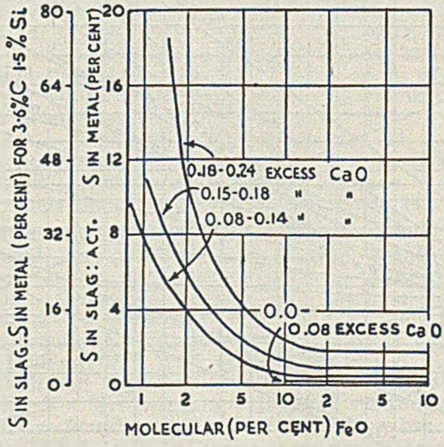


FIG. 13.—*Effect of Slag Composition on Desulphurization (after Rocca, Grant and Chipman).*

* As it has been shown that this ratio depends on the temperature T_R, the usefulness of the pyrometric control method put forward by R. I. Taylor is theoretically confirmed, and the factors cited, which cause variation between T_R and the gas phase temperatures, can be considered in relation to this device.[7]

achieved, and hence the final carbon content of the melt, will depend on (1) the original carbon in the charge; (2) the temperature of the melt; (3) the iron-oxide content of the slag; with (2) and (3) linking with (4) the iron coke ratio; (5) the coke-ash percentage and coke type; (6) the basicity of the slag; (7) the extent of the free-oxygen zones in the tuyere areas and (8) the blast temperature. Whilst this may appear to be a formidable list of variables for effective control, it will be seen that, on a steady running plant with a given type of charge, most of them can be made effective constants.

Ideal Melting Conditions

In summarizing the ideal cupola conditions for the melting of soft grey irons the following requirements are now postulated:—

(*a*) The minimum loss in melting of iron, carbon, silicon, and manganese.

(*b*) The ability to produce high-carbon iron, at a controlled level, from medium- or low-carbon charges.

(*c*) The ability to produce low-sulphur iron, at a controlled maximum level, from high- or medium-sulphur charges.

From these it can be concluded that:—

(i) The furnace will have to run with a high reaction temperature T_R.

(ii) The reaction zones, especially the free-oxygen zone, will have to be physically small and yet produce very high temperatures to ensure very hot metal.

(iii) The slag will have to be sufficiently basic to assist the desulphurizing reactions and carbon pick-up, though the lower the FeO content, the less basic need the slag be.

(iv) The slag must depend on materials charged only, *i.e.*, coke ash and fluxes and must not be contaminated erratically by lining material.

(v) The slag depth must be constant, to ensure constancy of metal/slag, slag/coke reactions.

It is contended, on a basis of the data produced, that requirement (i) can be met by the use of high coke ratios, but that it will be met much more economically by fairly high coke ratios coupled with hot-blast operation, the rich top gas being used in a recuperative system to heat the blast, thus improving the thermal efficiency, and simultaneously reducing the coke percentage necessary to achieve a given reaction temperature T_R, and, also at the same time, offering the simplest solution to requirement (ii), the production of reaction zones of very high temperature and zones of minimum free-oxygen. It would appear that efficiency in this direction will rise with increasing blast temperature, and the latter should be as high as present practical and economic recuperator design allows, otherwise coke ratios will still remain quite high, and thermal efficiency will suffer.

Requirement (iii) is a matter of charge calculation only, if (iv) is met. It is contended that this can be met fully by the use of complete water-cooling in the whole of the melting zone and tuyere zone, the tuyeres, themselves, being cooled also to enable them to withstand the temperatures required. To this should be coupled the use, in the well section, of a refractory incorporating graphitic material.

Requirement (v) is met by the use of continuous tapping through a syphon box, the slag depth being determined by the height of the external metal dam above the furnace tap-hole in the usual manner for such systems, and both metal and overflow slag being continuously and simultaneously removed and separated.

Conclusion

In conclusion, it is believed that the future of the cupola for quantity melting of soft grey irons lies in development along the lines suggested, and that it is in the field of metallurgical economics so opened up—where such irons can be produced using low-grade scrap iron, steel scrap, and ferro-alloys, as the only metallic raw materials, subjecting these to controlled metallurgical treatment—that the full application of hot-blast systems will be justified, rather than in the struggle to outweigh the high capital cost of such plant by the saving effected in coke on a normal cupola.

Finally the Author would like to thank the directors of Textile Machinery Makers, Limited, for permission to present this Paper, which arose from a review of results obtained by previous workers, and investigations now in progress on their behalf.

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DISCUSSION

Opening the discussion, MR. J. L. FRANCIS congratulated Mr. Fleming, saying he had made a thorough investigation of some of the variables affecting combustion and slag reactions in the cupola melting of cast iron. In order that they might take full advantage of such Papers as Mr. Fleming's it seemed to him that cupolas must be run under better control and on sounder engineering lines than at present in many cases. No engineer would dream of running a boiler without a water gauge and a pressure gauge, or would he have the fire-box in such a state that air could enter at random. Many cupolas were run under such conditions, except that air leaked outwards rather than inwards. Although things were constantly improving in foundries, there still was much slipshod practice and improvization of cupolas.

He was very pleased to see that Mr. Fleming had established on a factual basis a number of features which had previously been expressed mostly as opinions. Among these might be listed:—The importance of high reaction temperature and its

Reactions in the Cupola—Discussion

influence towards low iron-oxide production and the narrowing of the oxidation zone; the need for constant flushing away of coke ash from the fuel in order to increase the speed of combustion; the rate of carbon absorption, and the rate of the oxide reduction, as well as the advantages of maintaining an adequate and fluid slag blanket in the well of the cupola so that gas movement might be at a minimum and the high ratio of CO to CO_2 maintained.

Presumably, therefore, the production of a suitable slag as nearly as possible in the melting campaign was desirable and fluxing of the top layers of the coke bed would seem to be thoroughly justified. He asked Mr. Fleming if by efficient water-cooling at the tuyeres and melting zone it would be possible to run a sufficiently-basic slag to obtain desulphurization and at the same time employ normal acid lining refractories? He had in mind that perhaps the temperature of such acid refractories could be kept low enough to avoid serious reaction with the basic slag.

Charge Weight and Coke Bed

While variation in air volume and iron to carbon ratios on the operation of the cupola were dealt with in the Paper, no consideration had been given to the charge weight or height of coke bed. Surely these factors must be relevant. He understood that the study which Mr. Fleming had given them was really only the first phase of a more extended one, so perhaps he had been a little previous in criticizing it in that way. In that respect the practice employed by the German authors mentioned at the beginning of the paper, Jüngbluth and Korschan, for an experimental cupola seemed to be open to some comment. For a cupola of 21½ in. dia. (lined) an iron charge of 660 lb. was excessive. Normally, it would be 300 lb.—less than half. During melting of such a heavy charge there would be an excessive lowering of the bed coke.

Mr. Fleming agreed with Mr. Francis generally. He thought it was high time the cupola was regarded more as an engineering proposition than it had been hitherto, and suggested that some Continental founders at any rate were carrying that to a very advanced degree. It had always been an early tradition that the "know how" of cupolas had been a British affair and Lancashire in particular was famed for men who had the "knack" of making the cupola perform properly, but, as the subject had become more technical, foundrymen were losing that mastery to technical men who were prepared to put instruments on to their cupolas and treat them as highly-complicated apparatus.

As to whether it was possible to run a sufficiently basic slag with an acid lining—meaning an entirely normal acid lining—his answer, after due consideration, would be in the negative. It was desirable, to get effective slag reaction, to have a fluid and hot slag and he feared such a slag would attack an acid lining as normally constituted. There was one provision, however, that the material for the lining might be acid in character, but mixed with some 50 per cent. or so of graphite material then he would agree wholeheartedly that Mr. Francis' idea would be feasible. The type of lining materials which he thought would become most popular on cupolas where slag control was operated in practice were of a type which, while having a siliceous base, could almost be regarded as neutral linings due to the addition of graphitic material, and would serve with either basic or acid slags.

With regard to charge weight, Fig. 1 covered a large number of iron:carbon ratios, so that the ratio of iron to carbon charged had to embrace very wide limits, as members had no doubt realized. He presumed it had been realized that the unit charge weight of the metal was held constant—though he personally preferred to regard the coke weight as the constant and the metal charge as the variable. In that respect, he remained orthodox and had no quarrel with the coke constant computed to occupy some 6 in. or so of depth in the cupola shaft.

Starting *v.* Running Conditions

On the height of the coke bed, the only comment he would make was that the initial coke bed would have to be high enough to allow it to settle early in the "blow" to the operating level. He had implied in the whole of the Paper and in dealing with the combustion reaction, that the running coke bed height, when the cupola had become established, was not determined by what was put on in the first place: it was a function of the air volume and the type of coke being used (whether small or large coke), the temperature of the blast, and other variables which affected the bed. It was not directly determined by the air volume, but by the same factors which were cited in the Paper as fixing the melting-zone and the reduction-zone shape. However, he did not wish to imply that he regarded control of air volume, air velocities in the tuyere or tuyere size as unimportant. He had attacked the classical methods of calculating air volumes, but, obviously, one could not put in a half-ton block of metal at the top and melt it as it passed through a shallow melting and reduction zone and expect to get hot metal at the bottom. He believed there was a relationship between the rate of heat production in the melting zone, the size of the metal pieces used and the rate at which the coke level was falling due to the speed of combustion, which had to be re-examined, so that founders had a more sound basis on which to calculate air volumes.

He paid tribute in that respect to a previous Paper, by Cyzewski, on the optimum blast volume for cupola practice, where an attempt was made to calculate the correct air volume on the basis of the time it took to melt a piece of iron of a given size and the distance it travelled down the cupola whilst melting. It would follow that during that melting time it must be melted and superheated within the distance available or low temperature would result.

Application to Every-day Practice

Mr. Hughes said Mr. Fleming had put a great deal of research effort into the Paper and he was being very modest indeed when he said it contained no new work. It was a concise compilation and founders were able to see the whole matter in truer perspective.

It was further suggested that the work, which no doubt had its fullest value to the research worker, also had value for the cupola operator by reason of the importance attached to every-day running. However, he thought the conditions which Mr. Fleming suggested as necessary were so remote or even impossible that the normal method of calculating air volume was quite good and would continue to remain so. The Author had put forward suggestions for every-day control, but some would be difficult to maintain. One, in particular, related to metal size, an important factor in ensuring steady cupola operation. All knew that it was outside the realm of practicability to ensure and control uniform and regular metal size.

In connection with carbon control in the basic cupola, Mr. Fleming gave various points essential or desirable in obtaining carbon pick-up, but the speaker suggested that the most important factor was the basicity of the slag and if that were correct the others would fall into line.

Another point mentioned by the Author was the introduction of calcium carbide. Founders knew that the basic-lined cupola was considered more expensive in cost than the acid-lined cupola and that its main advantage came from desulphurization and carbon pick-up. As these could be accomplished reasonably well by normal slag composition, the need to add expense to the process should be avoided.

Carbon in the Lining Material

On page 12 of the preprint, reference was made to conditions that might be anticipated in the future and with that was mentioned a refractory incorporating graphitic material. The Author seemed to indicate that he was using a mixture of graphite with one of the normal refractories. On the other hand, he might be considering the usefulness of graphite itself in its introduction into the lining of the cupola and the fact that it was impervious even to acid or basic slags. Carbon certainly had a useful application, but one of the greatest difficulties with such refractories, particularly with regard to the cupola, lay in repeated heating and cooling. Where it was applied under conditions of high temperature and no fluctuation, then carbon had a very useful and long life. He feared its application in the cupola would not be so successful.

Mr. Fleming thought Mr. Hughes was correct—but he was sorry that he was—in that the normal method of blast calculation would still continue because it was so simple. He contended that the cupola was so accommodating that one could make drastic mistakes based on wrong premises and still get it to work, but improvements were nevertheless desirable.

He thought Mr. Hughes was not quite right about metal-size control; he was not suggesting that all metal should be charged into the cupola to a carefully graded size. It would be highly desirable, but not practical. He suggested that the coke ratio required to melt the metal satisfactorily would increase, the more the pieces of metal and the bigger they became.

On carbon control, he had stated a large number of variables, but he had also suggested that while it might appear a formidable list it would be seen that on a steady-running plant, with a given type of charge, most of them could be made effective constants. He had felt it necessary in his Paper to list the whole of the variables, but a running plant he agreed the job was really a matter of slag control.

Similarly, the admission of calcium carbide was only in the interests of scientific accuracy rather than a suggestion that that was the right and best method. He did not think it was. Carbon control could be effected by slag control, so long as the other factors were not allowed to deviate.

Continuous Cupola

With regard to the graphitic material to which he had referred: there were a number of those materials available, but they were all proprietary articles containing about 50 per cent. of graphite. They stood up well to erosive attack because graphite was non-wetting and that protected the rest of the refractory, but they did not give quite the same trouble with burning that Mr. Hughes expected because they were not a wholly carbonaceous material. On a running plant of high production capacity, which were the ones to which he had referred, it was a simple method not to drop the cupola completely, but merely to tap out, drain, and bank down for the night with a coke charge. There might still be difficulty, but (and this applied also to quite a large number of his statements) he had recently seen a plant with hot blast and full water-cooling, and the type of refractory described, running on a production basis without any special operators, where the variables had been restricted and working was largely a matter of slag control.

Courses in Higher Technology

Each year the Regional Council for Further Education for the South-West inquires of industry the need for special courses at an advanced stage that are known to the major industrial concerns in the south-west. Local education authorities then attempt to meet these requests through their technical colleges when the demand for courses appears likely to be adequate to warrant the holding of the courses. No hard-and-fast rule can be drawn about what constitutes an adequate demand, but local education authorities will give very careful consideration to a course that is wanted by as few as 10 persons. This is part of the service rendered by technical colleges to industry and, while education committees endeavour to obtain value for money, almost all courses of this type are financially aided both by the rates and by the Ministry of Education in an endeavour to provide the services of the best experts in the country at fees that can be met by students.

The courses (detailed in a bulletin) are all of an advanced type planned to assist industry and in practically all cases they are provided at the direct request of one or more concerns. Details may be obtained from Mr. S. F. Trustram, secretary to the Council at 12, Lower Castle Street, Bristol, 1.

News in Brief

THE ANNUAL DANCE of Qualcast, Limited, Derby, was held at the Assembly Rooms, Derby, on September 11.

ABOUT 400 PEOPLE attended the International Combustion, Limited's, swimming club's gala at the Queen Street Baths, Derby.

THE DISCHARGE of iron ore from the Swedish ship, Laidaure, at Sunderland South Docks for the works of the Consett Iron Company, Limited, was delayed owing to a shortage of wagons.

GUY MOTORS, LIMITED, Wolverhampton, have received an order for 55 " Arab " underfloor-engined bus chassis, from the Bombay Electric Supply and Transport Undertaking, of Bombay.

REPRESENTED BY 164 FIRMS, Britain was this year the largest exhibitor at Yugoslavia's annual trade fair, which was held recently at Zagreb. For the first time, Yugoslavia exhibited her own steel and steel products.

THE SWEDISH FOUNDRY EMPLOYERS' ASSOCIATION (*Sveriges Gjutmastareförbund*) held its annual conference on September 13 and 14. It included three technical papers—one on hot-blast cupolas—and a works visit.

LITHGOWS, LIMITED, Port Glasgow, has received an order from H. Hogarth & Sons, Glasgow, for a 9,000-ton cargo steamer. The propelling machinery will be supplied by John G. Kincaid & Company, Limited, Greenock.

LAST THURSDAY, agreement was reached between employers and the A.E.U. in Bradford that the Christmas-holiday period for engineering workers in the city should be Christmas Day, Boxing Day, and Monday, December 28.

A CONTRACT worth £570,000 has been secured by Ransomes & Rapier, Limited, Ipswich, for the sluice gates for the first stage of the Wadi Tharthar irrigation project in Iraq. The main constructional contract has been awarded to a German firm.

AS FROM SEPTEMBER 16, the Ministry of Materials has reduced its selling price for tungsten ores of standard 65 per cent. grade and ordinary quality as follows: Wolframite, from 327s. 6d. to 310s.; scheelite, from 312s. 6d. to 300s., per unit delivered consumers' works.

R. B. IRON & STEEL COMPANY, LIMITED, a new private company, was registered on September 7. The directors are Mr. John W. R. Roe, director of J. Dudley (Lye), Limited, and Roe Bros. (Dudley), Limited, and Mr. Richard Bloomer. The secretary is Mr. J. W. R. Rowe.

RETIRED EMPLOYEES of W. & T. Avery, Limited, were given the " freedom of the works " at the Soho Foundry, Birmingham, last Wednesday, and were able to meet old colleagues, see new machines, and renew acquaintance with the machines which they used before their retirement.

CONCESSIONS to large consumers of electricity in industry and commerce, with the object of encouraging them to use more power at off-peak periods, are contained in new tariffs announced by the South-West Scotland Electricity Board, which are due to come into operation on October 1.

DAVY & UNITED ENGINEERING COMPANY, LIMITED, of Sheffield, have secured contracts valued at £4,000,000 for rolling-mill equipment for installation in South Wales. The contracts have been placed jointly by Richard Thomas & Baldwins, Limited, and The Steel Company of Wales, Limited.

INVITATIONS are to be sent shortly to all Scottish manufacturing firms to participate in the Scottish Industries Exhibition to be held in the Kelvin Hall, Glasgow, from September 2 to 18 next year. The planning stage of the exhibition is now complete and already a large measure of support has been pledged.

GARTON & KING, LIMITED, of Exeter Foundry, Exeter, were the hosts at a dinner party held at the Imperial Hotel to all members of the staff with 21 yrs.' service or more. It was presided over by Mr. H. E. E. Holladay, the managing director, who himself has attained his " majority " with the company.

OCTOBER 7 has been fixed as the date on which the Engineering and Allied Employers' National Federation will meet the Confederation of Shipbuilding and Engineering Unions to reply to the unions' claim for a 15 per cent. increase in wages. The Shipbuilding Employers' Federation will meet the unions a week later to reply to the parallel claim in the shipbuilding industry.

A FRESH APPROACH to the Government, urging it to consider a scheme for co-ordinating the basic fuel industries—coal, electricity, and oil—is to be considered by the Scottish Fuel Efficiency Committee. The move has been prompted by the report of the Anglo-American Productivity Council team which has recommended co-ordination as the best means of using Britain's fuel resources.

THE NEW STEEL PLANT at Lackenby, Middlesbrough, of Dorman, Long & Company, Limited, commenced production on Saturday. A tilting furnace, claimed to be the largest in Europe, with a capacity of 360 tons, and a big mixer of 600 tons capacity, were brought into production. This week a second furnace was due to be lit, and later two more furnaces and a second mixer will come into action.

THE MINISTER OF SUPPLY has removed restrictions on the use of molybdenum in alloy steels as from September 21. Arrangements for economizing in the use of nickel and molybdenum in alloy steels were brought fully into operation in June, 1952, following consultations between the Minister, alloy-steel makers, and the main consumers. Restrictions on the use of nickel in alloy steels will remain for the time being.

MR. FREDERICK GRANT, Q.C., was appointed independent chairman of the British Iron and Steel Federation last week. He succeeds Sir Andrew Duncan, who died 18 months ago. Among the tasks of Mr. Grant, who is not well known in the industry, will be those of guiding it under denationalization; steering the second five-year plan for a production of 20 million tons by 1957, and aligning it with the Schuman Plan.

A REFRESHER COURSE for works and plant engineers is currently being held at Brasenose College, Oxford (September 21 to 25). The opening address was given by Rear Admiral Sir Sydney Frew, chief fuel engineer of the Ministry of Fuel and Power. The course has been designed to provide engineers in industry responsible for fuel utilization with an opportunity to bring themselves up to date in fuel efficiency technique.

THE FIRST PRODUCTIVITY COMMITTEE to be set up in the West Midlands under the plan sponsored by the British Productivity Council is to serve the area of Tipton, Dudley, Brierley Hill and Stourbridge. The chairman of the committee is Mr. H. C. Davies, assistant general manager, Midland section, of Richard Thomas & Baldwins, Limited, and the secretary is Mr. A. J. Burns, head of the department of production engineering and engineering trades at Dudley and Staffordshire Technical College.

THE VALUE of an " eyeable " product was stressed by

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News in Brief

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the Midland industrialist Mr. A. G. B. Owen, chairman of Rubery Owen and Company, Limited, when speaking at Brierley Hill on September 14. "We have found that an article, however workmanlike and sound, will not sell if it does not appeal in appearance to the public," he said. "If we are to increase our sales to dollar countries, we shall have to consider more and more the appearance of our goods."

Steam locomotives on British Railways are stated to be running more trouble-free miles than ever before. The latest statistics available, for the four weeks to June 13, show that the average mileage run between mechanical failures was 32,878, as compared with 19,174 for the corresponding period in 1949; 20,365 in 1950; 26,319 in 1951, and 32,183 in 1952. The improvement is attributed to the introduction of the standard examination system throughout British Railways.

An agreement has been reached subject to the completion of formalities for the acquisition by Tube Investments, Limited. of W. H. A. Robertson & Company, Limited. W. H. A. Robertson & Company, with works at Bedford, specialize in the design and manufacture of rolling mills for all metals in hot and cold state, ancillary rolling mill machinery, wire-drawing machinery, tube-manufacturing machinery, threading equipment and general engineering components. Like all Tube Investments subsidiary companies, Robertsons will continue to operate as a separate entity.

Vickers-Armstrongs' reorganization has now been taken a stage further by the appointment of Mr. G. R. Edwards, c.b.e., as managing director of the Aircraft Division, comprising Weybridge and Supermarine Works. Mr. T. Gammon, o.b.e., takes over the office of general manager of that Division. In December, within the Engineering Division, Mr. W. D. Opher is to become general manager of the Elswick, Scotswood, Wakefield and Chertsey Works, and Mr. J. R. Kelly general manager of Crayford and Dartford Works and in charge of the Whitehead torpedo works in place of Mr. W. D. Opher.

The latest firm to expand in Bathgate, West Lothian's "steel town," where more men work in foundries than in any other industry, is the North British Steel Foundry. Mr. Ian Menzies, one of the two brothers who run the concern, tells our local correspondent that a new melting shop is being erected. It will house the latest type of equipment, including a cupola of Belgian design, the first of its kind in Britain, which will increase the output of metal castings from 100 to 150 tons per week. The North British Steel Foundry is one of the few Scottish firms exporting castings to the United States.

It has been decided to wind up the national scrap metal drive at the end of this year. Announcing this, Mr. Hugh B. McKee, president of the National Federation of Scrap Iron, Steel and Metal Merchants, which, with the British Iron and Steel Federation, has been jointly responsible for the campaign, says that intensive efforts cannot be maintained. The drive, which has been pursued in its present form since June, 1948, has been worth while, according to Mr. McKee, who points out that a period must be allowed for further accumulation of scrap. The recovery of destructor scrap is to be continued, and, if possible, extended.

King George VI memorial fellowships are being sponsored by the English-Speaking Union of the United States to enable British men and women, aged between 17 and 29, to continue their scientific and technical education in American institutions. For the academic year 1954-55 up to 25 fellowships, each valued at $2,500, will be awarded to graduates of universities and students of technical colleges in Britain. Selection of candidates will be by a committee with headquarters at 37, Charles Street, London, W.1. Application forms and full particulars can be obtained from Mrs. D. R. Dalton, King George VI Memorial Fellowships Committee, at that address. Completed forms with supporting documents must be returned not later than November 14.

A report from the organizers states that the 19th Engineering, Marine & Welding Exhibition and Chemical Plant Exhibition, which closed on September 17, attracted 50 per cent. more visitors than that previously held two years ago. As a very high proportion of the visitors were either potential purchasers or persons directly connected with the engineering industry, this very large increase was most encouraging, and reports from exhibitors indicated that the majority were more than satisfied at the number of serious enquiries received. Many visitors remarked that it was the finest display of engineering equipment which they had ever seen, and, in particular, the Chemical Plant exhibition, which was held for the first time, was acclaimed a great success.

Interesting historical documents relating to the sale of the Bradley Works of John Wilkinson, "the father of the South Staffordshire iron trade," have been presented to Bilston Historical Society by an anonymous donor. Mr. J. S. Roper, secretary of the Society, believes that the papers, which were not known to be extant, will completely change previous conceptions of the extent of Wilkinson's ironworks near the town. One of the documents is a tattered sale catalogue containing a map, showing the Birmingham canal, which carried much of the ore to Wilkinson's works, and on which he launched the first iron boat. The papers indicate the exact house where Wilkinson and his family lived. Also shown are furnaces, forges, and the houses of Wilkinson's workmen.

Regional offices of the Board of Trade and the Ministry of Supply for the London and South-Eastern, Midland, and Southern Regions were combined from September 14. The names of the Controllers and the addresses are as follow:—*London and South-Eastern*: C. S. Toseland, Cromwell House, Dean Stanley Street, London, S.W.1 (until further notice communications on Ministry of Supply matters for this Region should continue to be addressed to the Controller, Mitre House, 177, Regent Street, London, W.1.); *Midland Region*: B. W. T. Kay, C.M.L. Building, Great Charles Street, Birmingham, 3; and *Southern Region*: F. A. Swann, Marlborough House, Parkside Road, Reading, Berks. In other Regions the Board of Trade and the Ministry of Supply will continue to operate independently.

The death of John Thomas Dowen (57), of Walsall, was caused by high blood pressure and simple pneumoconiosis, the deputy borough Coroner (Mr. A. H. Gregory) was told at an inquest at the Manor Hospital last week, and a verdict in accordance with the medical evidence was recorded. Dowen, who was employed as a moulder by F. H. Lloyd & Company, Limited, was said to have been under medical supervision at frequent intervals since he contracted pneumonia some years ago, and had suffered repeated attacks of bronchitis. He was advised in November last year to submit himself for examination to the Birmingham Silicosis Board. He did so and was found to be suffering to a small degree from pneumoconiosis and was granted a 20 per cent. disablement pension. On August 17 he was admitted to the Manor Hospital, and he died on Saturday last.

Illustration of Supinex "R" in use by courtesy of Diecastings Ltd., Birmingham 12.

Raw Material Markets

Iron and Steel

The pig-iron trade is still restricted by the slackness at the jobbing foundries. These establishments are not taking up anything like their normal quantities of No. 3 iron, and stocks of this grade are increasing. Makers of refined iron are also working at a reduced tempo. On the other hand, outputs of hematite and low- and medium-phosphorus iron are fully absorbed by the engineering and speciality foundries, and basic-iron supplies are not in excess of the requirements of the steel plants.

The re-rolling trade is still in the doldrums, chiefly because of the lack of foreign business. Continental producers of bars and light sections are offering supplies at prices below British quotations and, as a result, re-rollers have to rely almost exclusively upon home business, which is insufficient to keep the mills in full employment. This, in turn, exercises a limiting effect upon the demand for semi-finished steel just at a time when the steelmakers are in a position to supply bigger tonnages. As rapidly as circumstances permit, imports from Western Europe are being curtailed, but in the meantime stocks are accumulating and steelmakers find it difficult to dispose of defective material.

The position in the finished steel trade is still fairly strong and the tone of the market is rather more cheerful. There has been a marked improvement, for instance, in the sheet trade. Numerous oversea inquiries have come to hand and brisk bookings are reported to the end of the year. The shortage of steel plates persists, but German mills are reported to be offering marginal tonnages at reduced prices, and this may offer an opportunity of temporarily relieving the embarrassment of the shipbuilders and marine engineers. Heavy sections are obtainable with less delay, and the rail mills are fully employed, but the pressure for wire products has been considerably relaxed of late.

Non-ferrous Metals

There was rather an air of depression on the Metal Exchange in the middle of last week, but matters improved somewhat and a rather steadier tone was in evidence when business came to an end last Friday. In every case the close was above the lowest point reached during the week, but, nevertheless, it could hardly be stated with conviction that there are clear signs of the usual and normal autumn revival in trading in metals. The severe falls on Wall Street were a contributory factor to the bearish sentiment prevailing, for in many quarters it is being assumed that this weakness on the American stock markets is the herald of a general trade recession in the United States. Metal prices on the New York Commodity Exchange, for the most part, appeared to follow London and to take their cue from movements on the Metal Exchange. Trading on the other side of the Atlantic is moderately active, and in the case of copper, at any rate, forward quotations show a backwardation, as in Whittington Avenue. With July and August, the main holiday months, out of the way, the situation in the States should be improving and business picking up. Demand is certainly quite good, but in the case of lead and zinc, at any rate, the position is somewhat undermined by pressure of sales in the States of foreign metal.

As a result of last week's trading in London, copper closed with a gain of £5 in the cash position and of £3 10s. forward, after a turnover which was only moderate in volume. As in earlier weeks, the bulk of the business was done in the three months' position, the Continent being in evidence as a buyer. But some demand for early metal was seen and the Government broker sold on Friday last 100 tons at £237 10s. This price, it should be noted, is equal to approximately 29¼ cents per lb., so that there is, in fact, very little difference between New York and London. Where copper will ultimately finish up remains to be seen, but it is likely to be a long way below the present price level. Tin last week fluctuated to some extent, but finally closed with little change in cash and a drop of £2 in three months. Trading was only moderate. Lead was the weakest of all four metals, closing above the worst, but with a loss of £3 10s. in September and £2 5s. in December, the backwardation coming in to £3 5s. Zinc, too, recovered from the lowest to close with a loss of 17s. 6d. in September and 30s. in December.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* September 17, £232 10s. to £235; September 18, £232 10s. to £235; September 21, £232 10s. to £235; September 22, £232 10s. to £235; September 23, £232 10s. to £236.

Three Months: September 17, £218 to £218 10s.; September 18, £217 to £218; September 21, £219 to £219 10s.; September 22, £219 to £219 10s.; September 23, £219 to £220.

TIN, Standard—*Cash:* September 17, £605 to £607 10s.; September 18, £605 to £607 10s.; September 21, £609 to £610; September 22, £610 to £612 10s.; September 23, £617 to £618.

Three Months: September 17, £595 to £597 10s.; September 18, £600 to £602 10s.; September 21, £600 to £602; September 22, £600 to £602 10s.; September 23, £606 to £607 10s.

ZINC—*September:* September 17, £68 10s. to £68 15s.; September 18, £68 5s. to £68 10s.; September 21, £68 5s. to £68 15s.; September 22, £70 to £70 10s.; September 23, £71 15s. to £72 15s.

December: September 17, £67 15s. to £68; September 18, £67 15s. to £68; September 21, £67 to £67 10s.; September 22, £67 12s. 6d. to £67 15s.; September 23, £68 15s. to £69.

LEAD—*September:* September 17, £89 10s. to £90; September 18, £90 17s. 6d. to £91; September 21, £90 to £90 10s.; September 22, £90 10s. to £90 15s.; September 23, £92 15s. to £93.

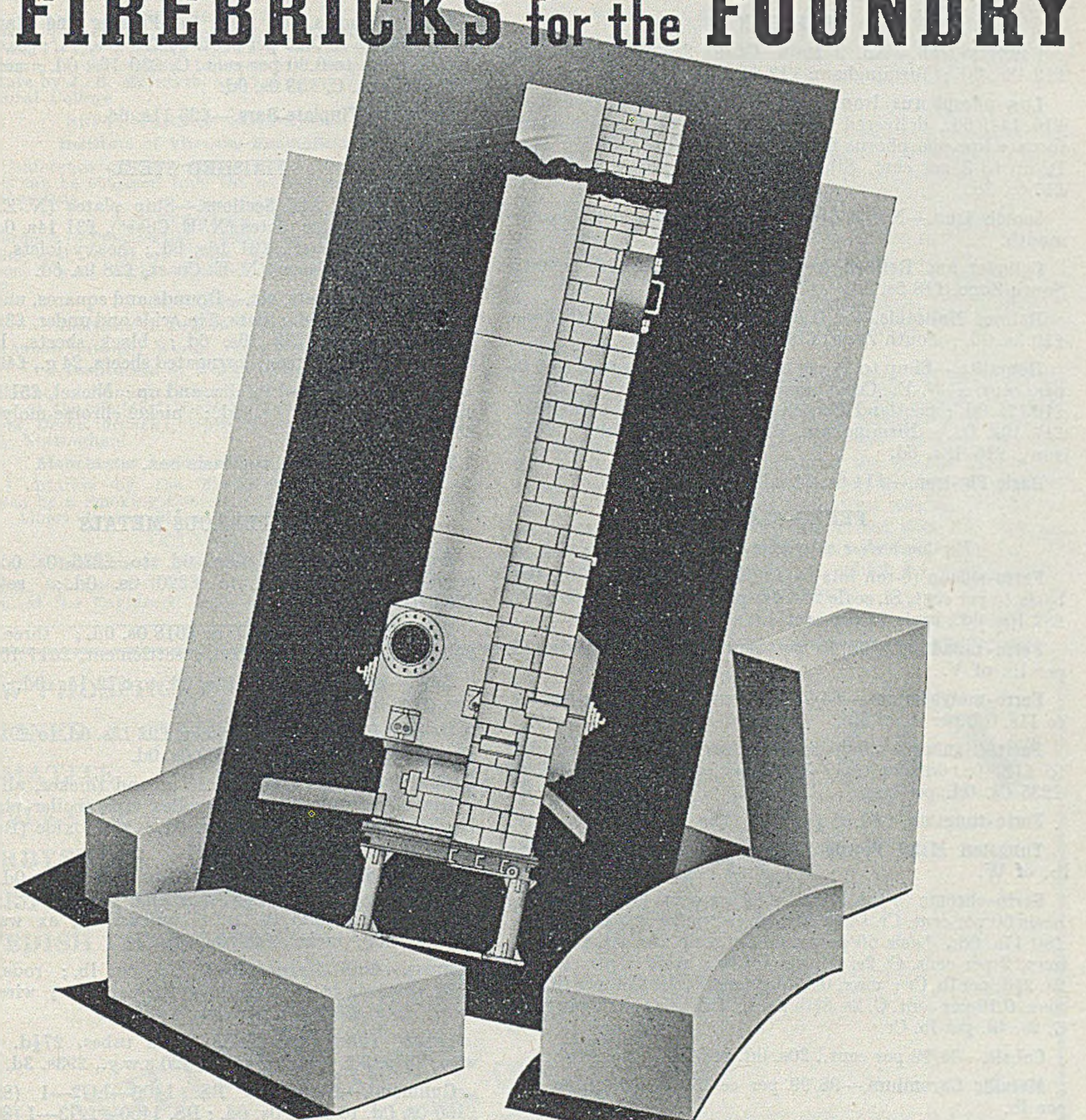
December: September 17, £86 7s. 6d. to £86 12s. 6d.; September 18, £87 15s. to £88; September 21, £86 15s. to £87; September 22, £87 5s. to £87 10s.; September 23, £88 15s. to £89.

International Foundry Activity

It is anticipated that nearly 60 members of the Institute of British Foundrymen and their ladies are participating at the International Foundry Congress this week in Paris. A large proportion of these are with the organized party, arranged by the Institute, which left London on Friday, September 18, and will return on Sunday, September 27.

In addition to representatives from most European countries, a large contingent of members of the American Foundrymen's Society and their ladies are present. The first party of Americans arrived in this country on August 25, and inspected foundries in the Birmingham and London areas.

A second small party of Americans will arrive in this country from the Continent on October 2, and the largest party of all will tour various Continental countries at the close of the Paris conference, and will be in this country from October 24 to 29. This party will include the president of the International Committee, Mr. L. N. Shannon, and the president, past-president, and secretary of the American Foundrymen's Society.



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

(Delivered unless otherwise stated)

September 23, 1953

PIG-IRON

Foundry Iron.—No. 3 Iron, Class 2:—Middlesbrough, £13 18s. 0d.; 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. 0d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £18 3s. 0d.; South Zone, £18 5s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £19 3s. 0d.; 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. 0d.; Scotland (Scotch iron), £16 18s. 6d.; Sheffield, £17 13s. 0d.; 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. 0d., basis 45 per cent. Si, scale 21s. 6d. per unit; 70/84 per cent., £82 10s. 0d., basis 75 per cent. Si, scale 23s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 10s. 0d. to 11s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £165 0s. 0d. to £181 0s. 0d. per ton; 38/40 per cent., £229 0s. 0d. to £235 0s. 0d. per ton.

Ferro-tungsten.—80/85 per cent., 20s. 0d. to per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 23s. 3d. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent. C, £85 4s. 0d., basis 60 per cent. Cr, scale 28s. 3d. per unit: 6/8 per cent. C, £80 17s. 0d., 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. 0d. per lb.

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

Metallic Manganese.—93/95 per cent., carbon-free, £225 0s. 0d. to £232 0s. 0d. per ton; 96/98 per cent., £255 0s. 0d. to £262 0s. 0d. per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 40s. 0d. to 70s. 0d. 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 0s. 0d.; silico-manganese, £33 16s. 0d.; free-cutting, £28 16s. 6d. Siemens Martin Acid: Up to 0.25 per cent. C, £32 12s. 0d.; case-hardening, £33 0s. 0d.; silico-manganese, £34 17s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic soft up to 0.25 per cent. C, £29 16s. 0d.; basic, hard, over 0.41 up to 0.60 per cent. C, £30 16s. 0d.; acid, up to 0.25 per cent. C, £33 0s. 0d.

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. 0d.; 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. 0d.; 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, £232 10s. 0d. to £236 0s. 0d.; three months, £219 0s. 0d. to £220 0s. 0d.; settlement, £236 0s. 0d.

Tin.—Cash, £617 0s. 0d. to £618 0s. 0d.; three months, £606 0s. 0d. to £607 10s. 0d.; settlement, £617 10s. 0d.

Zinc.—September, £71 15s. 0d. to £72 15s. 0d.; December, £68 15s. 0d. to £69 0s. 0d.

Refined Pig-lead.—September, £92 15s. 0d. to £93 0s. 0d.; December, £88 15s. 0d. to £89 0s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £99 0s. 0d.; rolled zinc (boiler plates), all English destinations, £96 15s. 0d.; zinc oxide (Red Seal), d/d buyers premises, £87 0s. 0d.

Other Metals.—Aluminium, ingots, £150 0s. 0d.; magnesium, ingots, 2s. 10½d. per lb.; antimony, English, 99 per cent., £225 0s. 0d.; quicksilver, ex warehouse, £64 15s. 0d.; nickel, £483 0s. 0d.

Brass.—Solid-drawn tubes, 22d. per lb.; rods, drawn, 31¾d.; sheets to 10 w.g., 246s. 9d. per cwt.; wire, 29⅝d.; rolled metal, 233s. 6d. per cwt.

Copper Tubes, etc.—Solid-drawn tubes, 27¼d. per lb.; wire, 264s. 3d. per cwt. basis; 20 s.w.g., 293s. 3d. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £160 0s. 0d. to £170 0s. 0d.; BS. 1400—LG3—1 (86/7/5/2), £170 0s. 0d. to £190 0s. 0d.; BS 1400—G1—1 (88/10/2), £252 0s. 0d. to £285 0s. 0d.; Admiralty GM (88/10/2), virgin quality, £252 0s. 0d. to £300 0s. 0d. per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £265 0s. 0d. to £295 0s. 0d. L.P.Bl, £215 0s. 0d. to £240 0s. 0d. per ton.

Phosphor Bronze.—Strip, 348s. 3d. per cwt.; sheets to 10 w.g., 370s. 0d. per cwt.; wire, 43⅞d. per lb.; rods, 38½d.; tubes, 36¾d.; chill cast bars: solids 39d., cored 40d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × .056, 3s. 0¼d. per lb.; round wire, 10g., in coils (10 per cent.), 3s. 5¼d.; special quality turning rod, 10 per cent. ½ in. dia., in straight lengths, 3s. 4¼d. All prices are net.

Forthcoming Events

SEPTEMBER 26

Institute of British Foundrymen

Bristol and West of England branch:—Film "Synthetic Resins," followed by a high tea and social evening, 3 p.m., at The Grand Hotel, Bristol.

SEPTEMBER 29

Birmingham, Coventry and West Midlands branch, Birmingham and West Midlands Students' section:—Address by Chairman, G. Cheeseman, followed by "Mould Materials," a lecture by J. B. McIntyre, and 7 p.m., at Wolverhampton Technical College.

SEPTEMBER 30—OCTOBER 3

Institute of Vitreous Enamellers

Annual Conference at Cheltenham, Gloucestershire. Further details can be obtained from the secretaries, John Gardom and Company.

SEPTEMBER 30

London branch:—Presidential Address by B. Levy, followed by film and report on "New Methods for Old," by F. Hudson, 7 p.m., at the Waldorf Hotel, Aldwych, London, W.C.2.

OCTOBER 2

Institute of British Foundrymen

Fourth Annual National Works Visits Day.

Institution of Works Managers

London branch:—Annual General Meeting and Film show, 7 p.m. at the Waldorf Hotel, Aldwych, W.C.2.

Notts. and Derby branch:—Open meeting, 8 p.m., Welbeck Hotel, Nottingham.

Manchester Association of Engineers

Inaugural Address by the President, H. Wright Baker, followed by a Smoking Concert, 6.45 p.m. at the Engineers' Club, Albert Square, Manchester, 2.

OCTOBER 3

Institute of British Foundrymen

Wales and Monmouth branch:—Film "Lloyds Nowadays," 6 p.m., at the Engineers' Institute, Park Place, Cardiff.

Obituary

MR. JAMES ALEXANDER STEWART, formerly foundry manager of Alley & MacLellan, Limited, air and gas compressor and vacuum pump manufacturers, of Glasgow, died last week.

MR. SAMUEL SPENCER VARNEY, managing director, and one of the founders of the Northern Malleable Foundry Company, City Road, Derby, has died at the age of 70. He was a member of the Derby Society of Engineers.

MR. ALFRED JAMES MANSELL, who had been general secretary of the Institute of Industrial Supervisors since its formation in 1948, has died at the age of 42. Mr. Mansell was on the staff of Joseph Lucas, Limited, for several years, and from 1947-48 was employed by the Admiralty to maintain liaison with Midland firms engaged on Admiralty work. He was hon. secretary of the Birmingham Productivity Council, hon. secretary of the Birmingham section of the Institution of Production Engineers, and a member of the Institute of Industrial Management.

LORD WESTWOOD, who was president of the Engineering and Shipbuilding Trades Federation from 1933 to 1936 and of the Confederation of Shipbuilding and Engineering Unions from 1936 to 1939, died on September 13 at the age of 73. During the second world war he was successively principal labour adviser, director of contract labour, and chief industrial adviser in the department of the Admiralty concerned with the building of merchant ships. He held many posts on national and local committees, in addition to which he served on the Boards of a number of companies.

CLASSIFIED ADVERTISEMENTS

PREPAID RATES: Twenty words for 5s. (minimum charge) and 2d. per word thereafter. Box Numbers 2s. extra (including postage of replies).

Advertisements (accompanied by a remittance) and replies to Box Numbers should be addressed to the Advertisement Manager, Foundry Trade Journal, 49, Wellington Street, London, W.C.2. If received by first post Tuesday advertisements can normally be accommodated in the following Thursday's issue.

SITUATIONS WANTED

FOUNDRY EXECUTIVE, with wide experience of technical sales and design of plant, desires appointment offering scope for keen energetic engineer.—Box 3760, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN (age 49) requires position with small Ferrous and Non-ferrous Foundry. Accustomed to full control. Available at once. A.M.I.B.F.—Box 3729, FOUNDRY TRADE JOURNAL.

YOUNG MAN with 7 years' experience in metallurgical analysis and 3½ years' responsible experience of cupola melting practice, desires minor position in which some time for classes is available. London area.—Box 3758, FOUNDRY TRADE JOURNAL.

COMPANY SECRETARY/ACCOUNTANT, 46, wide experience Iron and Non-Ferrous Foundries. Final Accounts, Taxation, Costing, Budgetary Control. Sound knowledge foundry practice.—Box 3755, FOUNDRY TRADE JOURNAL.

STEEL FOUNDRY WORKS MAINTENANCE ENGINEER, (age 33), requires new position home or abroad. Well versed i/c Heavy Plant Maintenance, Machine and Workshops Supervision, Development, installation, etc. Available at short notice.—Box 3752, FOUNDRY TRADE JOURNAL.

FOUNDRY TECHNOLOGIST, (Indian), (28), highest education foundry science, management; sound practical experience — premier Indian, English foundries, iron, non-ferrous; wide range of castings—jobbing, mechanised production. Desires position home, oversea establishment British Firm; would consider technical/sales representation abroad. Available for interview. — Box 3753, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

DIE CASTINGS: Manager required for Aluminium Gravity Die Casting Foundry near Manchester. Must be capable of full control. Salary according to qualifications. Full particulars to Box 3751, FOUNDRY TRADE JOURNAL.

FOREMAN required for Aluminium Alloy Gravity Die Foundry. Experienced first class man with initiative and capable of assuming responsibility for production and control of labour. Write giving details of previous experience and positions held, together with salary desired to: Personnel Manager, WILLIAM MILLS, LIMITED, Friar Park Foundry, Wednesbury.

SITUATIONS VACANT—*contd.*

WANTED: First class Iron Moulder, West London district. Good flat immediately available for suitable man. —Box 3743, FOUNDRY TRADE JOURNAL.

OLD ESTABLISHED Midlands Ferrous Jobbing Foundry requires Representative on Commission basis for London and South Areas.—Box 3724, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN required for Grey Iron Foundry in the Midlands, to take charge of moulders producing castings from 56 lb. to 5 cwt. Must have knowledge of cupola control, together with metallurgical qualifications. Write, with full particulars of experience and salary expected.—Box 3770, FOUNDRY TRADE JOURNAL.

FOREMAN required immediately for Non-ferrous Sand Foundry of engineering company, South Birmingham. Castings vary from a few ounces to 1,000 lbs. in weight, and applicants should be used to oil-fired crucible furnaces and floor, bench, and machine moulding. Permanent, pensionable position, with good salary, to a man aged 30/45, with experience of labour control. Apply, stating full details age, experience, and present salary, to Personnel Manager.—Box 3764, FOUNDRY TRADE JOURNAL.

AVELING-BARFORD, LTD., Grantham, require a Metallurgist primarily for the supervision of heat treatment processes and metallurgical quality control duties. This is a new appointment and the successful candidate will be required to establish a small Metallurgical Department capable of performing the above functions. Applicants should be of graduate or equivalent educational status and have had industrial experience in the fields outlined. Assistance with housing accommodation will be provided, if necessary. Replies, giving pertinent details and an indication of salary required should be forwarded to.—THE WORKS MANAGER.

APPLICATIONS are invited for the post of a Foundry Manager for a heavy steel Foundry that is being installed in India. Applicants must have first class technical qualifications together with a knowledge of steel foundry management, layout and design and detailed knowledge of all branches of steel casting production. Initially the work will be concerned with planning and construction and the recruitment of the necessary staff. The work calls for drive and initiative. A good salary with excellent prospects for an experienced man. Reply giving full details of experience, age, positions held with amount of emoluments received.—Write Box 7017, c/o CHARLES BARKER & SONS, LTD., 31, Budge Row, London, E.C.4.

SITUATIONS VACANT—*contd.*

WRIGHT & PLATT, LIMITED, the World's Largest Engineering Master Patternmakers, with own ferrous and non-ferrous foundry, with unlimited capacity, desire to appoint experienced representatives in some of the larger towns and districts on a part salary and commission basis. Write fully giving age, experience, connections, etc., to Irving Street, Birmingham.

OPPORTUNITY for Young Chemist with experience of enamelling techniques and foundry practice to join staff of leading company. Right man may later be offered executive appointment with South African branch. Write in confidence giving full details of training and experience to Box 3761, FOUNDRY TRADE JOURNAL.

FOUNDRY METALLURGIST required to control Laboratory of high-class Grey Ironfoundry in Birmingham. This vacancy offers a first-class opportunity to a man of 25/35 years of age, fully experienced in the chemical analysis of iron and steel, and in furnace and sand control. Applicants are invited to write giving full particulars of experience and salary required.—Box 3749, FOUNDRY TRADE JOURNAL.

FOREMAN MOULDER required for small partly mechanised Foundry, also plate and loose patterns, for firm engaged on Ranges, Grates and Engineering Castings, "Baxi" Patent Fires and Products. House will be found if required. Apply in writing, stating full particulars, age, wage required and experience.—RD. BAXENDALE & SONS, LTD., Ironfounders, Albert Street, Chorley, Lancs.

TECHNICAL REPRESENTATIVE required by Vitreous Enamel and Ceramic Colouring Oxide Manufacturers. Knowledge of Enamelling Trade essential. Position Superannuated. Applicants should state in confidence: age, their complete experience and salary required to MESSRS. MAIN ENAMEL MANUFACTURING CO., LTD., Gothic Works, Angel Road, Edmonton, London, N.18.

ELKINGTON & CO., LTD., Goscote Works, Walsall, require SHIFT SUPERVISORS for employment in their Refining Department and in their Blast Furnace or Cupola. Applicants should be fully experienced in the production of fire-refined copper and to mechanised plant. They should be able to maintain discipline and take full control if required.—Applications in writing, stating age and experience, to PERSONNEL MANAGER.

A FIRM, manufacturing precision aircraft instruments in South Wales, require young ASSISTANT METALLURGIST, approaching H.N.C., L.I.M., or degree standard. Preferably with some experience of physical testing, heat treatment and metallographic examination of ferrous and non-ferrous alloys.—Apply Box 3742, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*contd.*

DRAUGHTSMAN/ENGINEER. Opening offered by Ventilating Engineers to experienced young foundry maintenance Draughtsman. Some dust control experience desirable.—AIR CONTROL INSTALLATIONS, LTD., 19, Temple Street, Birmingham, 2.

FOREMAN required for Birmingham Foundry, experienced in pressure die castings, knowledge of brass an advantage. State experience and wages required.—Box 3762, FOUNDRY TRADE JOURNAL.

SALES AGENTS/REPRESENTATIVES required by F. & M. Supplies, Ltd., 4, Broad Street Place, London, E.C.2, manufacturers of Supinex "R" Core Binder, Ferro-alloy Briquettes, etc., in the following counties: Leicester, Derby, Notts., Staffs. (part of).

N.W. LONDON FOUNDRY producing non-ferrous sand castings require outside Representative or Agent preferably with Home Counties connections and car. Remunerative commission offered. Retired executive considered, whole or part time. Confidential. —Box 3754, FOUNDRY TRADE JOURNAL.

A COMPANY located near Niagara Falls requires a GRAVITY DIE DESIGNER for Non-ferrous Castings, with a minimum of five years' experience of actual design work in this field. A practical shop or toolroom background is essential with foundry experience desirable. Successful candidates will be interviewed in London during August or September. Reply, stating experience, age, and availability.—Box 3725, FOUNDRY TRADE JOURNAL.

IRON FOUNDRY in the West Riding of Yorkshire requires 2 Technical Assistants to train for posts of responsibility on the foundry floor. Applicants should be under 30 years of age, and should have had practical foundry experience in addition to a General Scientific Education. Both posts offer excellent prospects of advancement and salaries will be paid in accordance with age and ability. Reply giving details of age, experience, education and present salary to—Box 3746, FOUNDRY TRADE JOURNAL.

AGENCY

A PROMINENT Public Company in Australia, operating large steel foundries, forges and machine shops, seeks link with kindred concerns in Britain and Overseas Countries by acquiring manufacturing rights suitable for Australian requirements, proprietary lines in general engineering and new devices. Manufacturing rights involving steel castings would receive special consideration but not an essential condition. Suitable agencies would also receive consideration. Please write.—Box 25, POST OFFICE, Alexandria, Sydney, N.S.W., Australia.

PROPERTY FOR SALE

SMALL, BLACK COUNTRY FOUNDRY; Grey Iron; well laid out; fully equipped; floor and stump moulding. Low figure for quick sale.—Box 3713, FOUNDRY TRADE JOURNAL.

SMALL Iron Foundry for Sale, Yorkshire. Capacity up to 15 cwt. Freehold.—Box 3768, FOUNDRY TRADE JOURNAL.

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.

WANTED

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.

WANTED.—RD.5 or BT.5 Jolt Squeeze Turnover Moulding Machine.—Particulars of price, condition, etc., to HENRY WALLWORK & Co., LTD., Red Bank, Manchester, 4.

MACHINERY WANTED.

WANTED.—Indicating or Recording Thermometer. Any range, to include a working temperature from 200/400 deg. F., or equivalent, in Centigrade. Must be in good condition.—HILLSYDE FOUNDRY Co., Harriseahead, Stoke-on-Trent.

WANTED.—One Moulding Machine, manufactured by The British Moulding Machine Co., Ltd., Type AT4.—FELLING FOUNDRY, LTD., Abbotsford Road, Felling-on-Tyne. Tel. 82404.

WANTED.

Britannia Jolter. Table 21 in. by 17 in., with pin lift.
Core Drying Stove About 3 ft. by 3 ft. by 6 ft. high, fitted panel front trays, or small vertical type.
Pallett Conveyor. Plates about 3 ft. by 2 ft.
Box 3769, FOUNDRY TRADE JOURNAL.

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.
Air Compressor, 2,000 c.f.m. to 30 lbs. per sq. in.
Sand Mills, up to 6 ft. dia. pan.
Exhaust Fans, all sizes.
Box 3748, FOUNDRY TRADE JOURNAL.

MACHINERY FOR SALE

TWO Colemans C. N. Model Moulding Machines complete. Nearly new. Cost £400 each. Accept £100 each.—L. A. JULL, L.E.C. Factory, Bognor Regis.

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

FOR SALE.

7-ton E.O. Travelling Crane. Cabin controlled, 38 ft. span. Low price.
5-ton ditto. ditto, 58 ft. span.
7½-ton Elec. Lifting and Travelling Block.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.,
Hainge Road, Tividale, Tipton, Staffs.

Double Chamber Laboratory Fume Cupboard, made by George Becker; unused.
Three Temperature Indicators, 0/1,200 degrees Centigrade; unused.
Gas-fired Coke Oven, 0/500 degrees Centigrade, with two Kent Recorders and Thermocouples.

H. B. BARNARD & SONS, LTD.
Dudley Port, Tipton, Staffs.

MACHINERY FOR SALE—*contd.*

FOR THE DISPOSAL AND PURCHASE OF ALL TYPES OF FOUNDRY PLANT AND MACHINERY.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.,
Hainge Road, Tividale, Tipton, Staffs.
TIPton 2448.

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.

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.

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AIR COMPRESSORS.
STOCK OR EARLY DELIVERY.

1,000 C.F.M. Vee Rope Driven Two Stage Double Acting Water Cooled Broom & Wade, cyls. 12½ h.p., 20¾ h.p. L.P. × 8 in. stroke, speed 400 r.p.m. TS2K.
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325 C.F.M. M.D. Six-Cyl. Two Stage Air Cooled by Climax, cyls. 5⅝ and 4⅜ × 4¾ in. stroke. 90 h.p. S.R. Motor, E.C.C. Starter, Intercooler, on combined bedplate.
300 C.F.M. Motor Driven Twin Cylinder Water Cooled; cyls. 10 in dia. × 12 in. stroke; 70 h.p. S.R. Motor and Starter, 400/440/3/50.
200 C.F.M. Twin Cylinder Water Cooled; cyls 8½ in. dia × 10 in. stroke; 35 h.p. S.R. Motor and Starter, 400/440/3/50. B.W.D.23.
150 C.F.M. Twin Cylinder Water Cooled; cyls. 8½ in. dia. × 10 in. stroke; 35 h.p. S.R. Motor and Starter; 400/440/3/50. BW.22a.

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"SAND WIZARD" Shot Blast Machine for Sale. Barrel size, 44 in. by 40 in. Electric, 400 volts, 3-phase, 50 cycles. Machine almost new and in excellent condition, complete with sack-type dust extraction plant. Offers.—Box 3766, FOUNDRY TRADE JOURNAL.

1 CUMMING Jolt Table Moulding Machine. Table size, 20 in. by 30 in.
1 Cumming Jolt Table Moulding Machine. Table size, 30 in. by 40 in.
1 Holman Foundry Floor Rammer. Size 20R.
1 6-cwt. Bogie Ladle.
2 6-in. Portable Wolf Grinders.
1 manually-operated Time Clock.
1 Lister Diesel Engine, twin cylinder, 10-12 b.h.p., 600/650 r.p.m.
H. HEWINS, LTD., Port Foundry, Brimscombe, Glos. Tel.: Brimscombe 2239.

One B.M.1 Sand Mill, by Foundry Equipment. Surplus to requirements. As new.
One Crocodile Jaw Type Cropper, to take up to ⅜ in. plate, by Brookes. In full working order.
Two Tilghman's Shot Blast Cabinets, 30 by 30. Rotary Barrel type, with two nozzles. Barrel 19 in. long, 2 ft. dia. Complete with Motors, dust arrestor, etc.
One Core Making Machine—Rocket, by Coggen.
Three Alldays & Onions No. 24 Duplex Fans, 7 in. outlet.

SYKES & HARRISON, LTD.,
Port Penrhyn Foundry, Bangor, N. Wales.

FOR SALE.

NO. 16 ATRITOR CRUSHER by Alfred Herbert, complete with Feed Hopper, overhauled and with a quantity of spares. Also a No. 12 Atritor by Alfred Herbert, for which we have available about 6 tons of spares. Both these machines are offered at extremely low prices for quick clearance.

SAVILLE-CALVERT (MACHINERY) LIMITED.
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NEW motorised Ingersoll-Rand three cylinder, air cooled, two-stage Compressor with inter-cooler, £200.
Coleman Core Blowing Machine, seen little use, condition as new, size R2 £375.
Portable electric sieve, A.C. motorised £33.
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Over 40 Bale-Out Furnaces in stock, cheap.
Large stock of Air Receivers at reasonable prices.
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Two new ½ ton aluminium capacity Lip Axis Tilting Furnaces by British Furnaces, complete with all equipment cheap.
Spare firebrick linings.
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Immediate attention to all enquiries.

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Australia Road, Slough.
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MACHINERY FOR SALE—*contd.*

600

CRANES.

NEW 10-ton Rushworth two-motored Electric Derrick Crane, with 120-ft. Jib. Motorized 400/3/50.

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Anderson-Grice 5-ton two-motor Electric Derrick Crane, new 1950. With 120-ft. steel jib and complete with B & A automatic safe load indicator. Visible and audible warnings. Motorized 400/3/50.

Several new Rushworth, 2, 3 and 5-ton capacity Hand Derrick Cranes, with 50-ft., 60-ft. and 70-ft. Jibs.

Two Tate 6-ton, 4 motor, Electric Mobile Cranes, fully slewing and fed by overhead cable. Mounted on 4 twin solid-tyred wheels, fitted 24-ft. lattice cantilever jibs. Complete with cabs and suitable for 415/3/50.

Jones "Super" 40, 3-ton Mobile Cranes, fitted 30-ft. lattice Jibs, and powered by Ruston or Turner Diesel Engines. Mounted on crawlers and each complete with Cab.

Several Jones "Super" 22, 2-ton Mobile Cranes, fitted Cantilever Jibs, and powered by Ruston or Turner Diesel Engines. Mounted on pneumatic tyred wheels and each complete with Cab.

3½/5-ton Portal Wharf Crane by Derrick & Hoist Construction Co. Rail centres 15 ft. Length of Jib 64 ft. 5-motored, voltage 440/3/50. Weight approx. 70 tons.

New B. H. & C. "Pingon" 30/100-cwt. Tower Cranes. Practically self-erecting, load handled along full length of jib, no load swing, instantaneous control. Lifts up to 129 ft. outreach to 82 ft.

New Portable House Building Crane, by The British Hoist & Crane Co. Will lift 10 cwt. at 17 ft., 5 cwt. at 35 ft. radius. Lifts up to 48 ft. Easily erected by two men.

New Brayda Electric Tower Cranes, 1½-ton at 65 ft. radius, max. load 69 cwt. max. height of hook 130 ft.

GEORGE COHEN
SONS & CO., LTD.
WOOD LANE, LONDON, W.12
Tel: Shepherds Bush 2070
and STANNINGLEY nr. LEEDS
Tel: Pudsey 2241

MACHINERY FOR SALE—*contd.*

FOR SALE.

3-TON Smith Steam Crane, suitable 4 ft. 8½ in. gauge, fitted with steel jib suitable for loads of 3 tons, 2 tons and 1½ tons at 16 ft., 20 ft., and 25 ft. respectively; having vertical cross-tube coal fired boiler, with usual mountings and complete with new cab. (Two available).-

NEWMAN INDUSTRIES LTD.,
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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.—70 Sterling Steel Moulding Boxes, 19½ in. pin centres, 7 in. deep, 16⅜ in. inside, beading top and bottom, fitted with double lugs, drilled for ⅜ in. dia. pins, two central lifting handles, and wedge clamping keys. In very good condition.—ARTHUR LYON & Co. (ENGRS.), LTD., Park Works, Stamford, Lincs.

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IMMEDIATE capacity available for Iron Castings up to 2 tons. Machine Tool Castings, etc.—H. H. MARTIN & Co., LTD., Sunningend Works, Cheltenham, Glos.

CAPACITY available for Light Castings weighing from 1 lb. to 5 cwts., including Castings for Vitreous Enamelling. WESTERN LIGHT CASTINGS FOUNDRIES, LTD., Fairwood Foundry, Gowerton, near Swansea, manufacturers of malleable iron castings.

NON—FERROUS FOUNDRY — First-class quality castings in Aluminium, Bronze, Gunmetals, etc., at competitive prices, including patterns if required.—BEESTON LEE & Co., LTD., 33, Swindon Road, Stratton St. Margaret, Wilts.

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NEW Foundry, starting for the sole production of Shell Moulded Castings, ferrous and non-ferrous, invites enquiries for Castings suitable for this process.—Replies in first instance to Box 3735, FOUNDRY TRADE JOURNAL.

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CAPACITY available for Gravity and Pressure Dies in Brass, Aluminium, Zinc; also Patterns for Shell Moulds.—NEVSTANE FITMENTS, LTD., Sheephouse Farm, St. Annes Road, London Colney, Herts.

CAPACITY available for castings weighing from 1 lb. to 15 tons, including Quasi-Bessermised ingot moulds up to 10,000 tons per annum.—THE CROSS FOUNDRY & ENGINEERING CO., LTD., Gorseinon, near Swansea.

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MISCELLANEOUS

STEEL.

SURPLUS stocks available in variety of sizes, mostly small, Flats, Rounds, Angles in black. Rounds, etc., in Bright. Particulars and prices upon application. —Box 3767, FOUNDRY TRADES JOURNAL.

MANURE, especially suitable for Foundry work and as supplied to the trade for over 25 years. Quotations on request.—FRANK GINSTER, Moxley, Wednesbury. Phone 0688 Wednesbury.

FIREWOOD for Cupolas. Sleepers and Sleeper Wood in wagon loads.—TILLEY'S (WOLVERTON), LTD., Wolverton, Bucks.

REFRACTORY MATERIALS.—Moulding Sand, Ganister, Limestone, Core Gum; competitive prices quoted.—HENSALL SAND CO., LTD., Silver Street, Halifax.

NOW is the time to change your Supplier of Sand. Try Southport Wind Blown Sea Sand for castings, free from shell. Any quantity, Road or Rail —JOHN LIVESEY (AINSDALE), LIMITED Ainsdale, Southport. Telephone: Southport 77489.

GRAPHITE / PLUMBAGO: Qualities available for every industry; special Foundry Plumbago; your enquiries are welcomed and will receive personal service.—WOODSTOCK (LONDON), LIMITED, 33 The Little Boltons, London, S.W.10 FREmantle 6646-7.

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PATTERNS for all branches of Engineering for Hand and Machine Moulding.—FURMSTON AND LAWLOR, LTD., Letchworth.

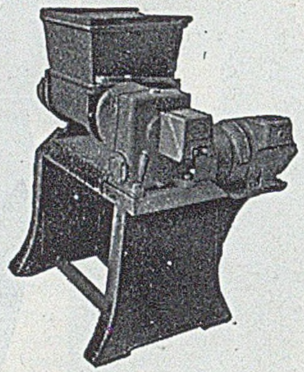
PATTERN EQUIPMENT of all types and sizes. Accurate workmanship. Quotations by return.—HAYWOOD BROS., Victoria Works, Littleborough, Lancs. Tel. 8543.

PATTERNS in Tin for the Stove Grate industry, and Builders' Merchants' Castings. All types of Cast Iron Patterns for Rain Water Goods. Cast Iron Pattern Plates made from customers' patterns or to drawing specification.—ROBERT R. SHAW, Falkirk Road, Larbert, Scotland. 'Phone 300.

PATTERN Equipments, Machined Plates, Castings, Components, Assemblies, Jigs, Fixtures, Corebox Air Vents and Dowels. Developing firm requests enquiries. Keen personal attention.—BOOTH BROS. ENGINEERING, Baggrave Street, Leicester.

PATTERNMAKERS' *Section*

"CUMMING" lines

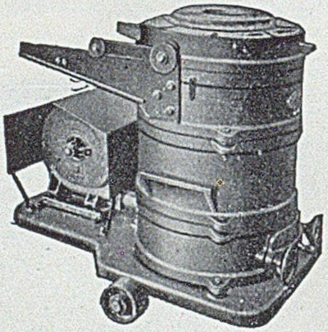


Sand Mixers have motor driven gears running in oil, replaceable blades, capacity 60 lbs. every 5½ minutes. Floor space 4ft. x 3ft.

Hand Rammed Moulding Machines to turn-over and down-draw. Boxes up to 30in. x 18in. (standard 15in. x 15in.) can be handled.

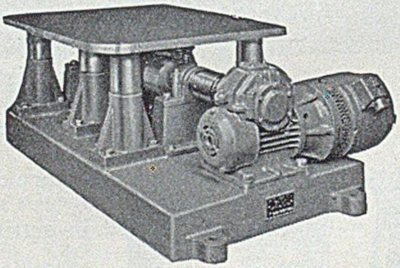
Electric Sand Riddle with automatic discharge. It is a very great labour saver. A 24in. round riddle can be supplied if preferred. Suitable for use with or without tripod.

WILLIAM CUMMING & Co Ld.
KELVINVALE MILLS
MARYHILL GLASGOW
AND AT
FALKIRK
CHESTERFIELD
DEEPFIELDS
MIDDLESBRO
Est. 1840



The Cumming Crucible Melting Furnace which is widely known as among the best of its type, requires only half of the coke of a pit fire and has three times the output.

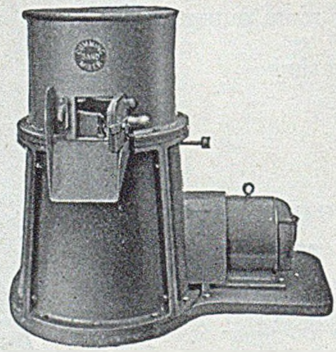
In sizes 60 lbs. to 500 lbs. All types have drop bottom.



Patent Jolt Moulding machine eliminates hand ramming.

Patterns are never damaged by jolt ramming, no compressors, air receivers, or air pipes needed. Wear and tear are very light.

Made in 5 sizes



C.I.V. Type Sand Mixer.
Cast iron body
is designed to handle about 1 cwt. sand.

Discharge is through a hinged gate, and the machine completely clears itself in about 30 seconds. From starting the machine to completion of discharge of the green sand requires about 4½ minutes.

SINEX HIGH FREQUENCY VIBRATORS AND VIBRATING SCREENS

3 Ton Model Illustrated

Larger and smaller machines available

We cordially invite you to visit us on Stand No. 3. Row Z Ground Floor, Empire Hall, Olympia. Sept. 3 - 17/1953.

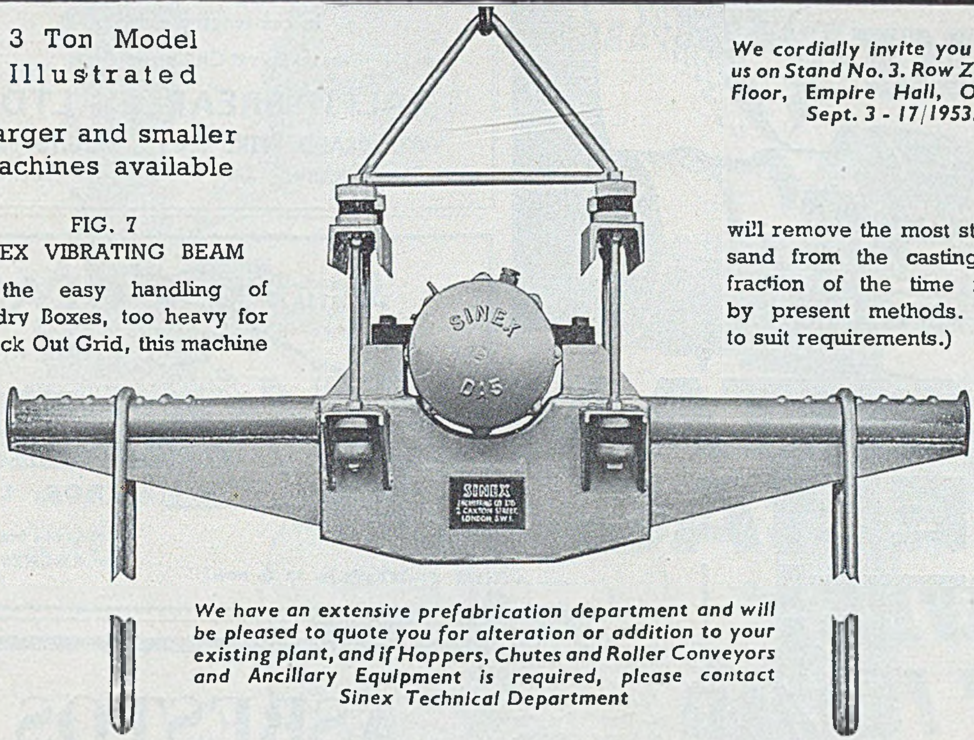


FIG. 7
SINEX VIBRATING BEAM

For the easy handling of Foundry Boxes, too heavy for a Knock Out Grid, this machine will remove the most stubborn sand from the casting, in a fraction of the time needed by present methods. (Links to suit requirements.)

We have an extensive prefabrication department and will be pleased to quote you for alteration or addition to your existing plant, and if Hoppers, Chutes and Roller Conveyors and Ancillary Equipment is required, please contact Sinex Technical Department

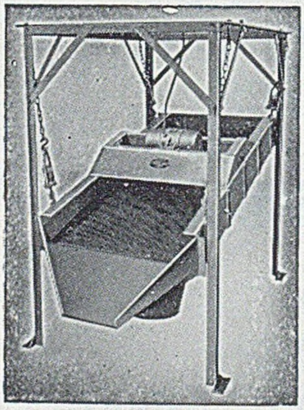


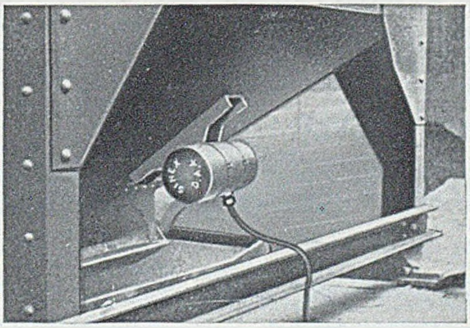
FIG. 10 (on left)

Sinex Vibrating Screen 6ft. × 3ft. Single Deck. Hourly output—15 tons of sand through $\frac{3}{8}$in. mesh.

This screen is also manufactured in sizes to suit requirements.

FIG. 8 (illustrated below)

An important function of Sinex High Frequency Vibrators is the application to Sand and Storage Hoppers. To facilitate the rapid discharge of the material, long experience has shown that the fitting of a Sinex Vibrator to a Hopper containing the most stubborn material will avoid "arching" or "funnelling" of the material in the neck of the Hopper and assure a regular flow. Fig. 8 shows a Sand Hopper fitted with Sinex Vibrator. Manufactured in various sizes suitable to the capacity of the Hopper, and wound suitable for any electric supply, single or 3-phase A.C.



THE **Sinex**

ENGINEERING CO., LTD.

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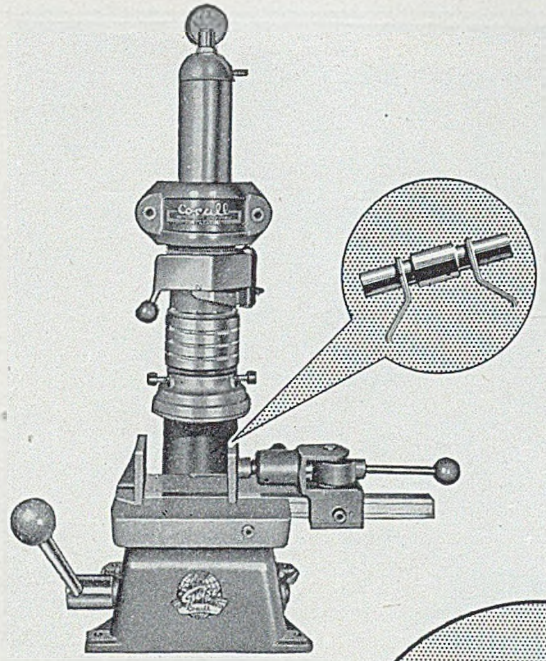
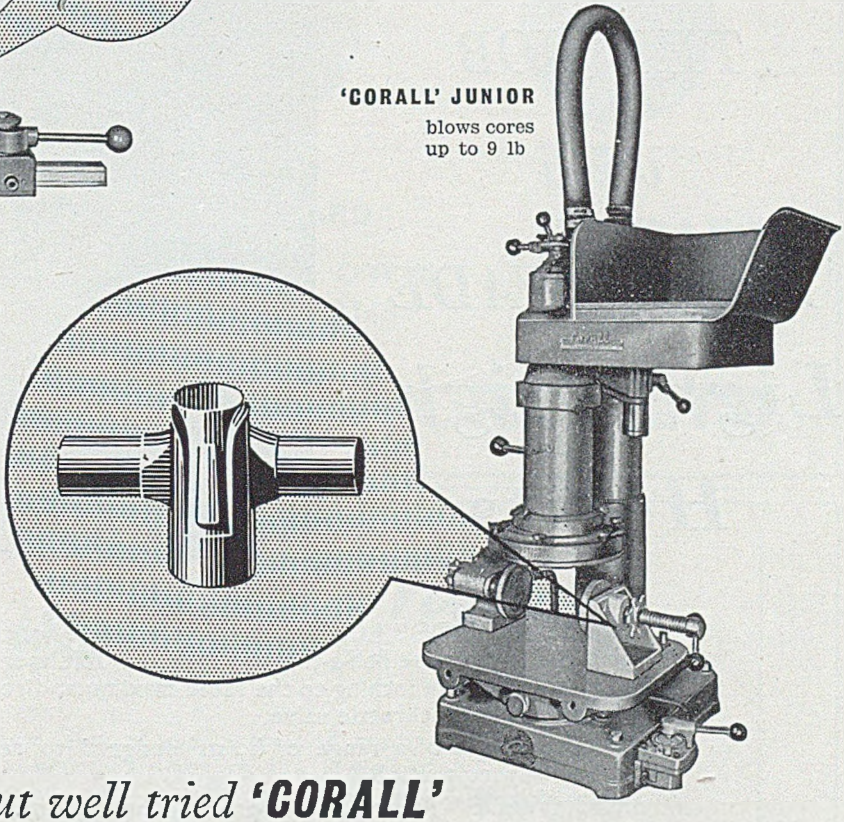
FOR SPEEDY AND ACCURATE CORE BLOWING



'CORALL' MINOR
blows cores
up to 2 lb



'CORALL' JUNIOR
blows cores
up to 9 lb

THE NEW *but well tried* 'CORALL' CORE BLOWING MACHINES

Features which have already found great favour with British foundrymen:

- Rapid adjustment for core-box set-up
- Swift action by single operating lever
- Self-venting blow-plate
- Air-Speed Regulator for sand of varying green strength

Sponsored in the U.K. and the Commonwealth by **FORDATH**

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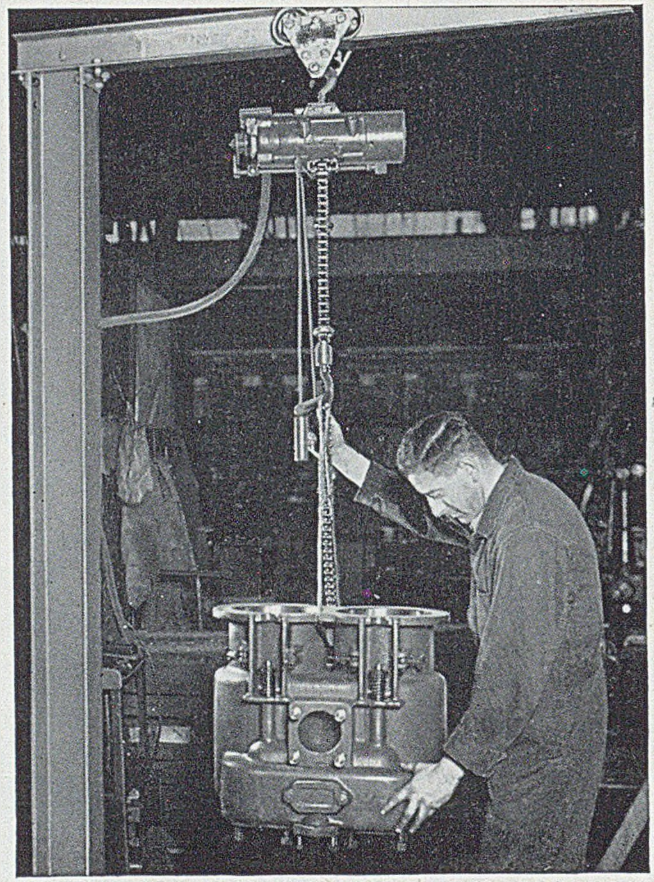
TELEPHONE: West Bromwich 0549, 0540, 1692 TELEGRAMS: Metallical, West Bromwich

SPEED THE JOB with "BROOMWADE" Lightweight Hoists



This "BROOMWADE" RCB10 portable pneumatic hoist is a *real* lightweight—yet it can raise half-a-ton at a speed of 26ft. per minute. The speed is variable from inching to the rated maximum, directly controlled by a highly sensitive throttle valve.

The RCB10 is one of a range of hoists designed to reduce handling time and to speed the job.

"BROOMWADE" Pneumatic Equipment is built to meet *your* requirements.

"BROOMWADE" offers you:

- Expert technical advice on all your compressed air problems.
- Complete world-wide after sales service.
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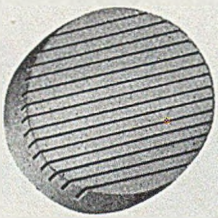

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