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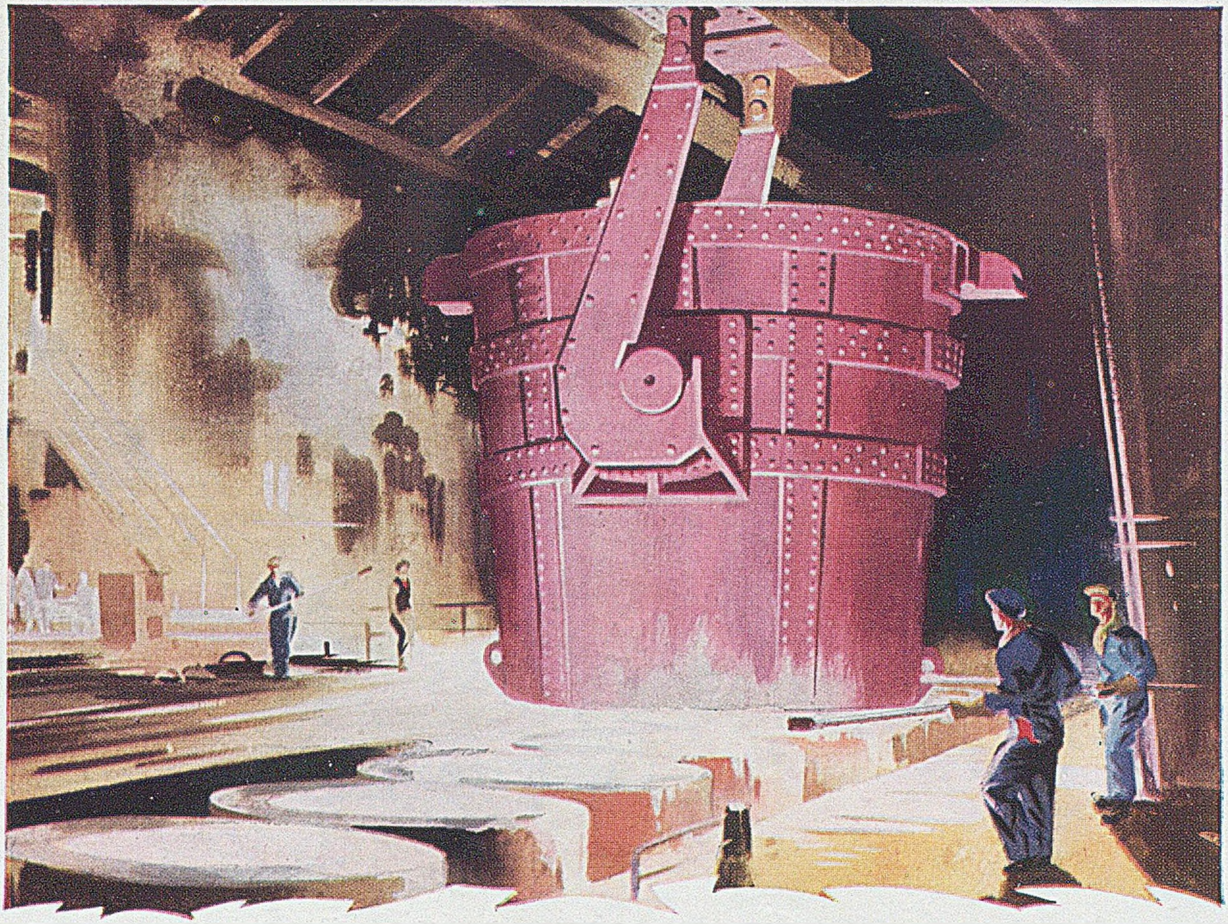

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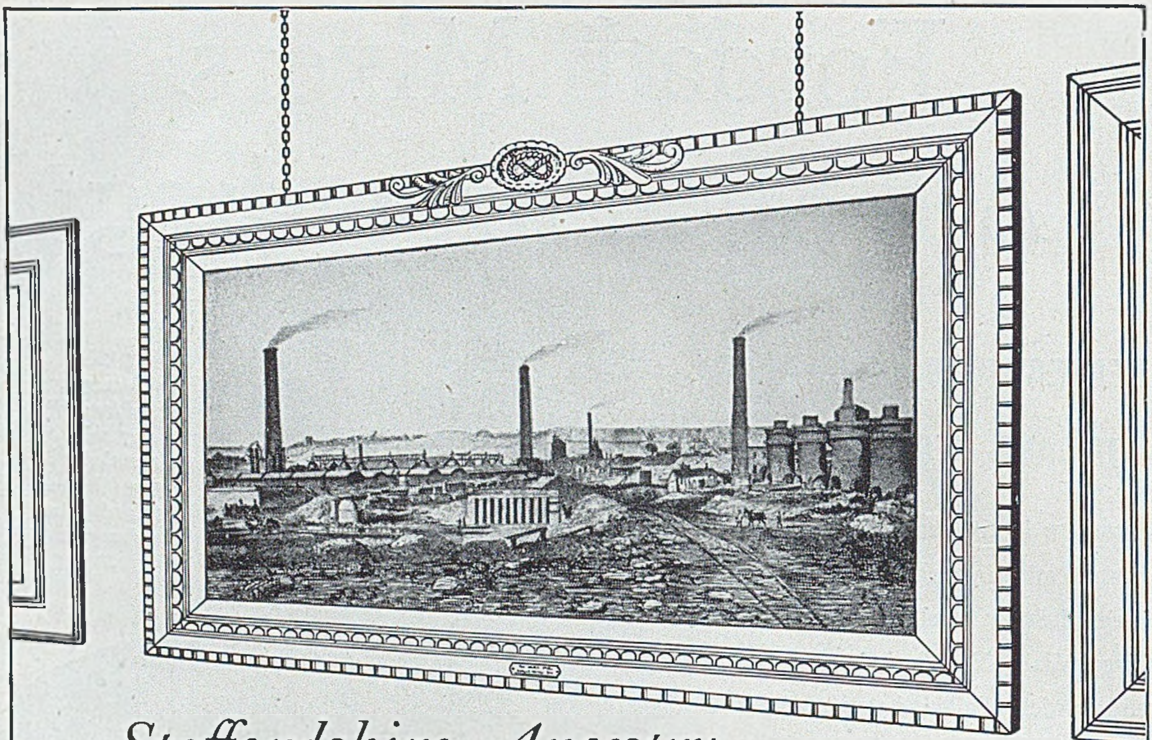


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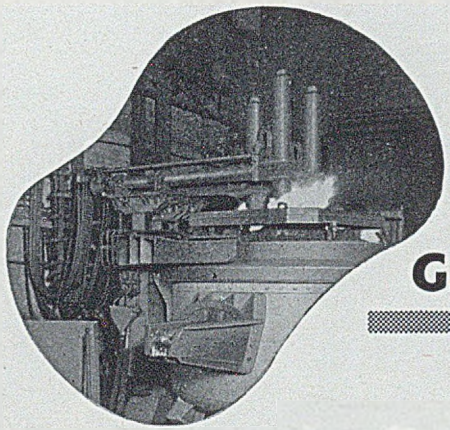

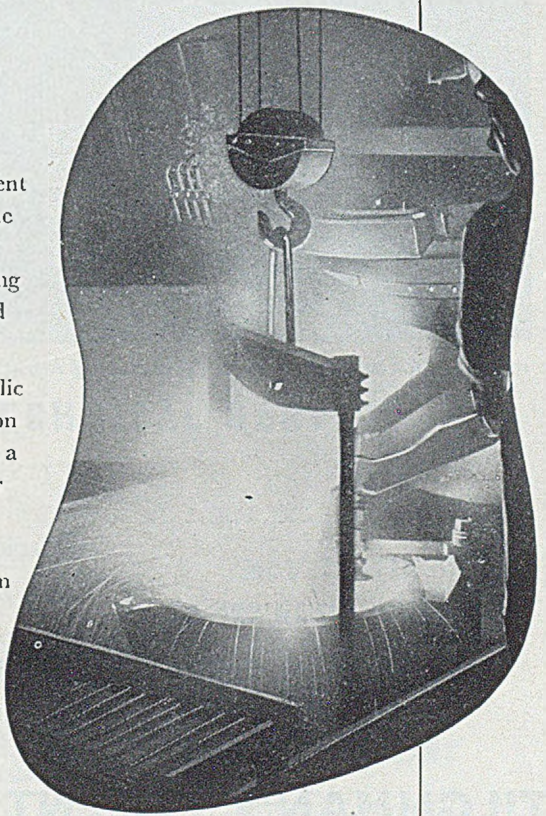

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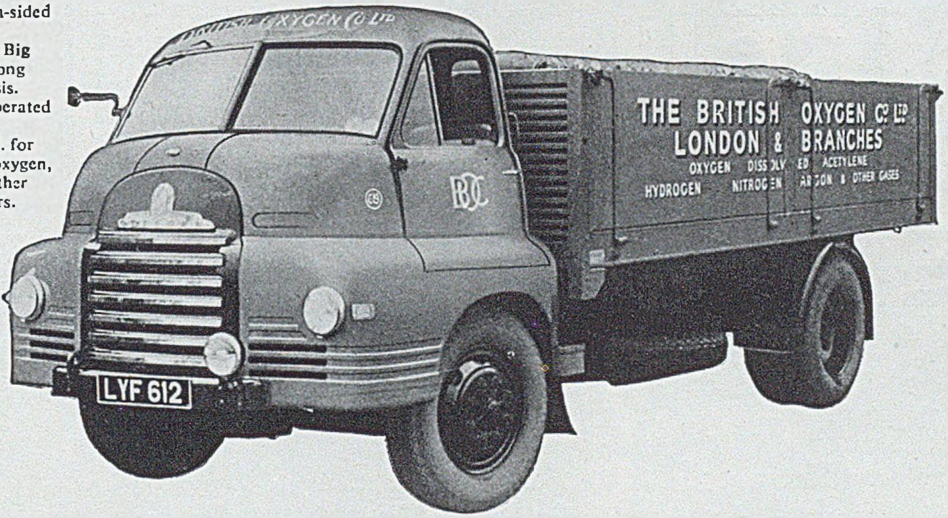

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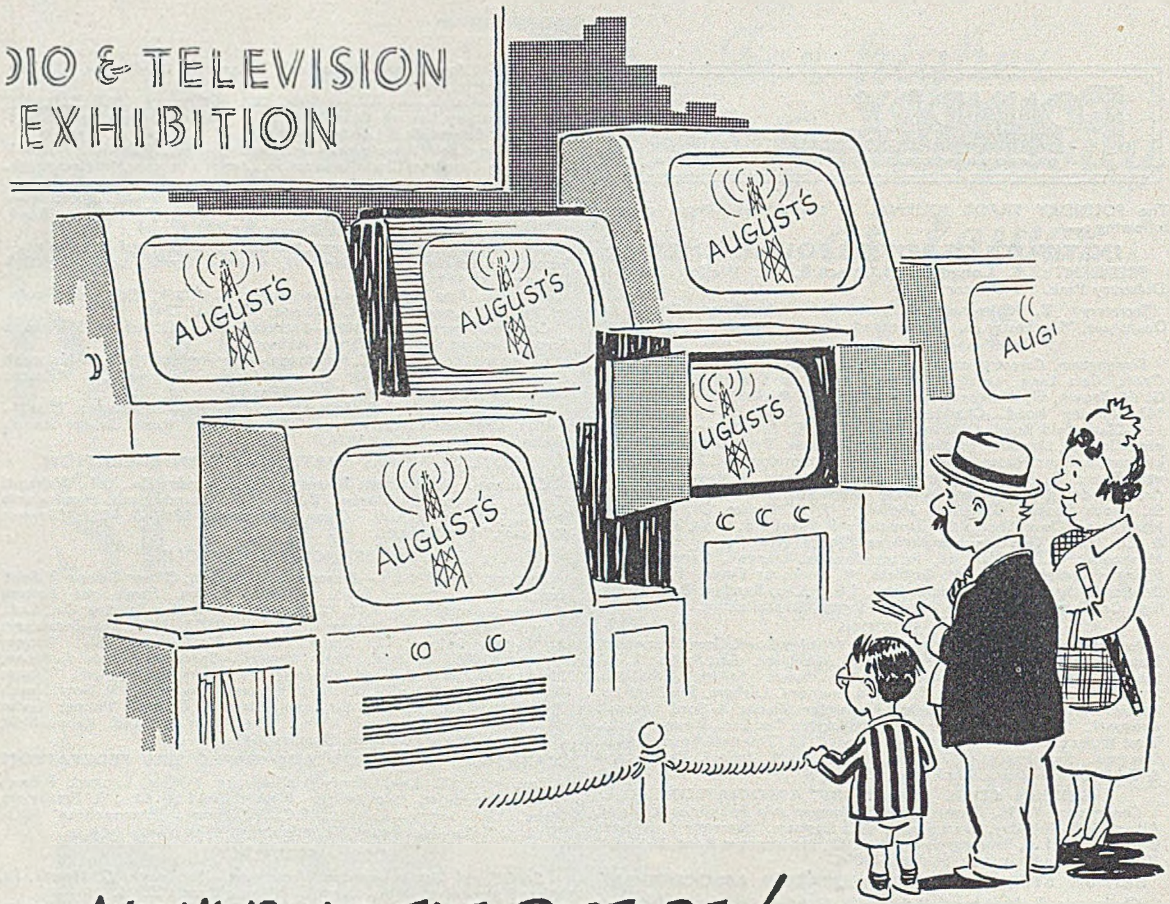

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PRINCIPAL CONTENTS

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Olympia

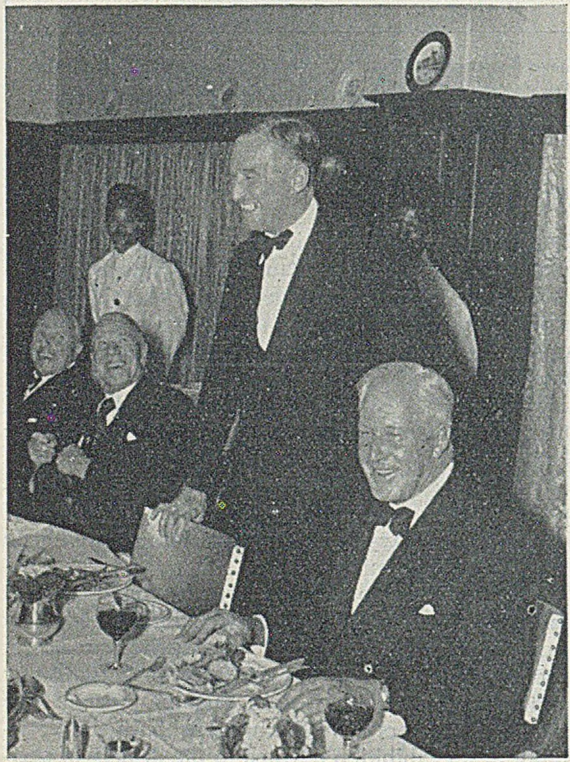
The designation of the exhibition now running at Olympia is "Engineering, Marine and Welding Exhibition and the Chemical Plant Exhibition," which is rather a mouthful and we should imagine that if it had been held on the other side of the Atlantic it would have been known as EMWEX and KEMPLEX or some other simplification. Whilst these contractions based on initials are to be deplored, so too is a title demanding over 60 letters for its expression. We think for the future "The Engineering Exhibition" should suffice, even though it may involve every fourth year the deletion of the sub—or will it be sub-sub—title ". . . and Foundry Exhibition." This sub-title, *per se*, is a misnomer, as it really means that there is incorporated a "Foundry Equipment and Supplies Exhibition." No matter what the title, no engineering exhibition can be staged without an unwitting exhibition of castings for the essential parts in machine construction.

This year, we are particularly impressed by the display of castings not only as built into machines but also as shown on the stands of actual foundries, and where castings are too large, photographs have been used. In this connection, a picture of the largest steel casting ever made in this country is prominently featured on one important stand. It was pleasing to see instances where foundry concerns have displayed with pride highly-enlarged pictures of their shops. Moreover, though this year's show is not billed as a foundry-equipment exhibition, there is plethora of this type of plant being displayed. There is a new type of shell-moulding machine being shown, but on the opening day it was out of action owing to the "gorilla" activities of the electricians' trade union, which in addition in various ways affected a fifth of the 600 or more stands. Then, there are a few firms showing pneumatic and electric hand tools for the foundry, whilst others display alloys for remelting, refractories, crucibles, compressors, conveyors, enamelling and other types of ovens, fans, fluxes, ladles, safety clothing, synthetic resins, and sand mixers.

The founders, too, are present in full force and there are many exhibits of steel; stainless; high-duty iron; light repetition and special iron castings; bronze alloys of many types, and both sand-cast and die-cast aluminium-alloy castings. From time to time, founders have discussed with us the possibility of an exhibition devoted to the display of castings. Whilst admittedly there are neither art nor builders' castings on show at Olympia, the former do not figure prominently at other exhibitions and we see but little use in having an exhibition resembling a museum. However, we do commend the exhibition now being held as showing a thoroughly interesting and representative collection of a wide diversity of castings as applied to engineering. Moreover, there are so many other exhibits to enhance the pleasure of a visit.

Southern Rhodesian Meeting

The Meehanite Metal and Development Association held a regional meeting at Bulawayo, Southern Rhodesia, in June, during the period of the Rhodes Centenary Exhibition. At the dinner, over which Mr. H. Issels presided, Mr. C. R. Hutchins, O.B.E., the chairman of the Rhodesian Iron and Steel Corporation, was the principal guest, and in proposing a toast said the first casting made in the colony was produced by Mr. Issels' father in 1895. In 1938, the Rhodesias imported 348 tons of pig-iron, which by 1952 had grown to 15,000. He suggested that an association of the local foundrymen should be formed. A full technical programme had been organized to cover two full days. Mr. A. G. L. Lewis not only presented two papers but also presided over several sessions. Other papers were given by Mr. B. Haigh; Mr. T. D. Davidson; Mr. H. Tenbes; Mr. J. A. Waller; and Mr. A. R. Cluett. Additionally, four film strips were shown. This was probably the first time any foundry technical congress has ever been held in Central Africa, unless King Solomon organized one in connection with his local mining interests.



Left to right: C. W. Ridge, director, Rhodesian Cables, Limited; D. M. Davidson, managing director, East Rand Engineering Company; C. R. Hutchings, chairman, Rhodesian Iron & Steel Commission; H. Issels, chairman, F. F. Issels & Sons, Limited.

Two 56-ton dock gates for the Regents Canal Dock, London, ordered by the Docks and Inland Waterways Executive, have been despatched by Head, Wrightson & Company, Limited, Thornaby-on-Tees.

Interesting Exhibits

The day before the "Engineering" exhibition opened at Olympia, a preview was held of an exhibit to be staged by the Mond Nickel Company, Limited, at Thames House, London. The central portion of the assembly consisted of two gapped piston-rings—one of a normal grey iron and the other of spheroidal-graphite cast iron. By the depression of a lever, an equal stress was placed on both, but the gap in the S.-g. iron ring opened to a much greater extent than that of the normal material. At the right-hand side of this set-up, was a manually-operated bending machine and here the S.-g. iron made a perfect 360 deg. bend, using a $\frac{1}{2}$ in. by $\frac{1}{8}$ in. strip. Then on the left, there was a hand-operated twisting test in which well-developed spirals could be made. When taken to fracture, there was present a distinct odour of acetylene emanating from the S.-g. iron. On the stand at the exhibition there are being shown recent developments of S.-g. iron in such fields as heat-resistance and the like. By appealing to the engineer in this way, the actual founders of the new iron should reap some material benefit.

More "Excess Price" Offences

What were described as "phoney invoices" were produced at Tipton Magistrates' Court last Tuesday when a foundry firm pleaded guilty to 21 charges of contravening Government regulations controlling the purchase price of scrap metal by buying the metal at more than the controlled price. Prosecuting for the Ministry of Supply, Mr. G. S. Preston said the first seven charges against the firm were in respect of the purchase of heavy machinery cast-iron scrap and the remaining charges concerned the purchase of light cast-iron scrap. The offences had come to light when a Ministry of Supply Inspector, Mr. R. C. Kemp, visited the firm and found that invoices did not tally with the amounts of scrap entered in the books.

The firm was fined £10 on the first offence and £3 on each of the other 20 offences (£70 in all) with 21 guineas costs.

A fine of £280 with £10 10s. costs was imposed on Frederick Foster, Limited, Anchor Bridge, Birmingham Road, Oldbury, when the firm pleaded guilty at Oldbury to 56 summonses involving scrap iron under the Defence (General) Regulations, 1939, and the Iron and Steel Scrap Order, 1950. Thirty-five of the summonses were for selling the scrap iron above the maximum price, and the remaining 21 for buying scrap iron above the controlled price. The company asked for similar offences to be taken into consideration.

Mr. E. G. H. Beresford, who appeared for the company, said that Midland ironfounders in 1951 found themselves neglected by a Ministry of Supply regulation which allocated scrap iron to foundries.

At Burnley Magistrates' Court, last week, Cooper Bros., Limited, and the Sandholme Iron Company, Limited, both ironfounding concerns, of Burnley, which were charged with paying more than the permitted prices for scrap iron, were fined a total of £70 on 14 counts and a total of £85 on 17 counts respectively, and were ordered to pay £5 5s. costs each. Walter Wallace, James F. Pollard, and Thomas H. Wilson, trading as James Alderson & Sons, Burnley, were fined £165, with £5 5s. costs, for selling at excess prices.

All three firms pleaded that supply difficulties could not be overcome at permitted prices, that extra profits were not made, and that the sales were concerned with material urgently wanted for production in the "national interest."

Production of Spheroidal-graphite Cast Iron in a High-frequency Furnace

By B. Jones, D.Sc., and R. Jelley

Most of the output of spheroidal-graphite cast iron in this country is obtained from the melting of pig-iron, return scrap, and steel scrap in cupola furnaces. The obvious reason for this method is on economic grounds, the melting cost being low as compared with that from other furnaces owing to the relatively low overheads and cost of fuel, and, moreover, the casts can be included in the daily run, or, for convenience, can follow the daily routine of normal casts. In the early days, when making trial casts of s.-g. cast iron from cupola charges, some difficulties were found in obtaining consistently good results, due to the unsuitability of the pig-irons then available. Then it was also difficult to obtain supplies of pig-iron that were sufficiently low in phosphorus and manganese to give the optimum mechanical properties. For these reasons, the casts tended to give some irregularity in properties, as shown by variable ductility of the metal in the annealed condition. This was reflected in imperfect microstructures, which showed incomplete spheroidization of the graphite, part of the graphite being retained as small quasi-flake particles. At this stage, the work described in this article was put in hand, using an acid-lined high-frequency electric furnace. It should be stated that suitable grades of pig-iron, which gave satisfactory results by cupola melting, were available subsequently.

In 1949, when difficulties were experienced in the cupola melting of spheroidal-graphite cast iron, the Authors carried out some exploratory melts in an acid-lined high-frequency electric furnace. The furnace used was one of the E.F.C.O. 12-cwt. units in the steel foundry of W. A. Baker & Company, Limited. A preliminary heat was made by melting Swedish white pig-iron and ferro-silicon, as this was considered to be a suitable charge for the production of nodular cast iron, owing to the very low sulphur, manganese and phosphorus contents of the charge.

Advantages of Electric Melting

The advantages of high-frequency melting are:—(1) The weight of the charge is accurately known, and the use of a suspended spring balance or of compressed air to remove fumes is not required; (2) the composition of the melt is closely controlled; (3) there is no sulphur pick-up, as with cupola melting; (4) the melt can be superheated readily and adjusted to the required temperature; (5) with a known amount of sulphur in the metal, the addition of the magnesium alloy for spheroidizing treatment can be calculated accurately; and (6) experience showed that there was a slightly higher recovery of magnesium than from cupola-melted cast iron.

With a bath of low-sulphur content, moreover, the minimum addition of the magnesium alloy can be made, with a saving of expensive alloy. It is well known that the sulphur must be removed almost completely by reaction with magnesium before the latter can be retained and the graphite spheroidized. During the melting of the Swedish pig-iron, the temperature of the metal was kept relatively low and, before tapping, was raised to 1,450 deg. C., as measured by an immersion pyrometer. The addition of the magnesium/nickel alloy was made to the ladle during tapping, the metal being well stirred and skimmed, after which the required amount of ferro-silicon inoculant was added. After further stirring and skimming, a clover-leaf test-block was cast, together with experimental castings. The mechanical test results

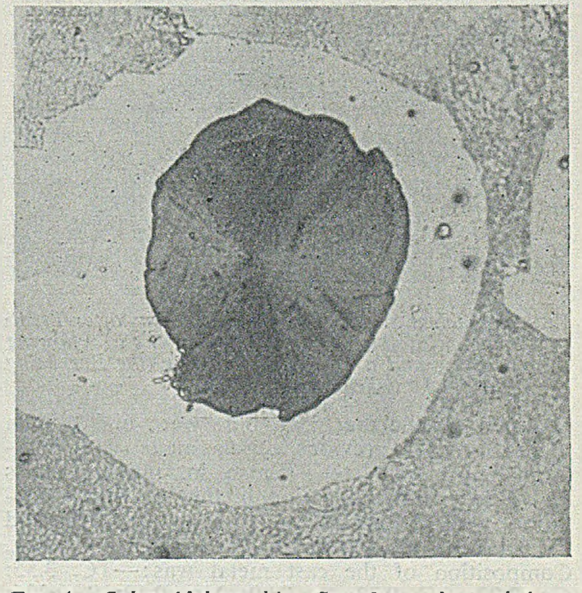


FIG. 1.—*Spheroidal-graphite Cast Iron obtained from H.-F. Melting of Swedish Pig-iron, showing a Graphite Spheroid surrounded by Ferrite (As-cast and etched, ×750).*

* The Authors are now attached, respectively, to W. A. Baker & Company, Limited Newport, Monmouthshire, and Renshaw Foundry Limited, Staines, Middlesex.

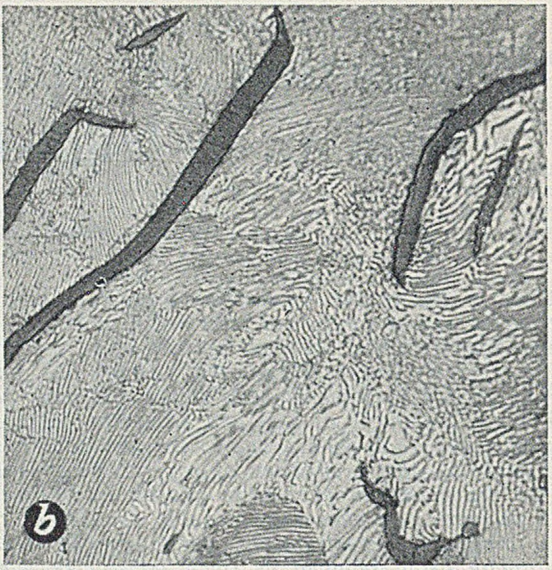


FIG. 2.—*Synthetic Flake-graphite Grey Cast Iron. (a) Unetched × 100; (b) Etched × 750, for which the Relevant Test Results are quoted in Table I.*

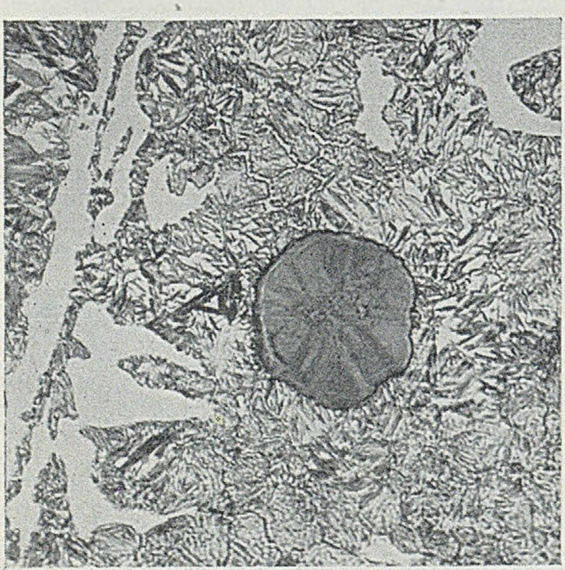


FIG. 3.—*Etched Structure of S.-g. Iron Bar after Treatment with Mg Alloy, but not FeSi, showing Mottling and a Martensitic Matrix (the Bar being "stripped" when hot);* ×750.

obtained on the machined bars were higher than those from the previous cupola melts, with minimum figures of 44 tons per sq. in. ultimate stress and 4 per cent. elongation in the "as-cast" condition, and 32 tons per sq. in. ultimate stress and 15 per cent. elongation on 2 in. after annealing. Composition of the cast metal was:—TC, 3.55; Gr, 3.22; CC, 0.33; Si, 2.90; Mn, 0.18; S, 0.006; P, 0.030; Ni, 1.30; Mg, 0.09; Ti, 0.01; Cu, 0.03; Cr, 0.005; and Mo, 0.005 per cent.

The microstructures of the "as-cast" metal showed that the graphite was mostly spheroidal and surrounded by ferrite, as illustrated in Fig. 1, the ferritic envelopes being typical of a casting with a low-manganese content. There was at least 50 per cent. ferrite in the "as-cast" structure. It was found that the volume of shrinkage cavity in the clover-leaf feeder-head was much less than that previously found in similar castings poured from cupola-melted metal.

Carburization of Steel Scrap

In spite of the better results obtained, it was obvious that the comparatively high cost of melting pig-iron of special grade in an electric furnace would be too expensive for production casting, and it occurred to the Authors that this cost could be reduced appreciably by melting mild-steel scrap, if this material could be readily carburized to a sufficient degree to produce a synthetic cast iron of suitable properties. The foundry was associated with a steel works from which source there was available a supply of mild-steel round bar croppings from the rolling mills, this form of scrap being normally used for charging the H.F. furnaces for carbon-steel castings. The advantages foreseen were that special grades of pig-iron and cast-iron scrap, required for the production of nodular cast iron by melting in a cupola or other type of furnace, would not then be required, whilst, owing to a cheap source of the one raw material, *viz.*, steel scrap, the total melting cost would be nearer to that of the cupola melting of special charges. Reference has been made to the other advantages. As regards chemical composition, the available steel scrap of basic-open-hearth quality and standard specification, had a low phosphorus content below 0.04 per cent. (often with less than 0.035 per cent.), which was highly desirable for the object in view, whilst the sulphur content was less than 0.06 per cent. with much of the stock below 0.04 per cent. This would result in a saving of magnesium alloy as compared with cupola-melted iron. The most suitable steel scrap would have a low manganese content, 0.3 per cent. and under, when available, and a high silicon content, such as silicon steel scrap with 4 per cent. silicon, which could be diluted with ordinary steel scrap, with a subsequent saving in ferro-silicon additions. With the other advantages of close control of charge weights and temperatures of melting and casting, etc., these were factors to be considered carefully in the economic assessment of electric-furnace melting *vis-à-vis* cupola melting for the production of high-quality castings of s.-g. cast iron. It may be of interest to record the production trials and subsequent heats in the manufacture of s.-g. iron castings by this new technique.

PRODUCTION OF S.-G. CAST IRON BY CARBURIZATION OF MILD-STEEL CHARGES

Synthetic Cast Iron from Steel Scrap

In April, 1950, trials were made to increase the carbon content of a 12-cwt. charge of mild-steel scrap in the H.-F. furnace to produce a cast iron of suitable quality. Various carburizing agents were tried to increase the carbon content of a steel charge by approximately 3 per cent., as their efficiencies were unknown. After various tests, Acheson recarburizing compound (crushed electrodes) was used as the carburizing agent, containing 95.5 per cent. fixed carbon and 4.0 per cent. ash. Sufficient ferro-silicon was added before tapping to incorporate approximately 2½ per cent. silicon in the metal. In the first instance the molten synthetic cast iron was cast into pig moulds and test-bars.

The steel scrap for this test consisted of rolled bars of the composition:—C, 0.18 to 0.24; Si, 0.2

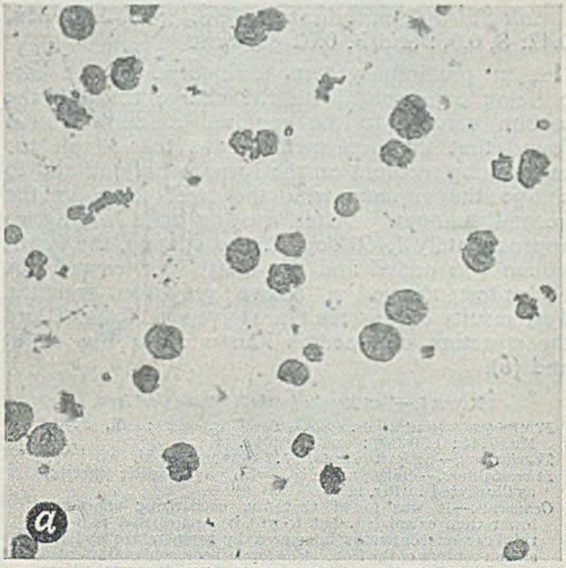
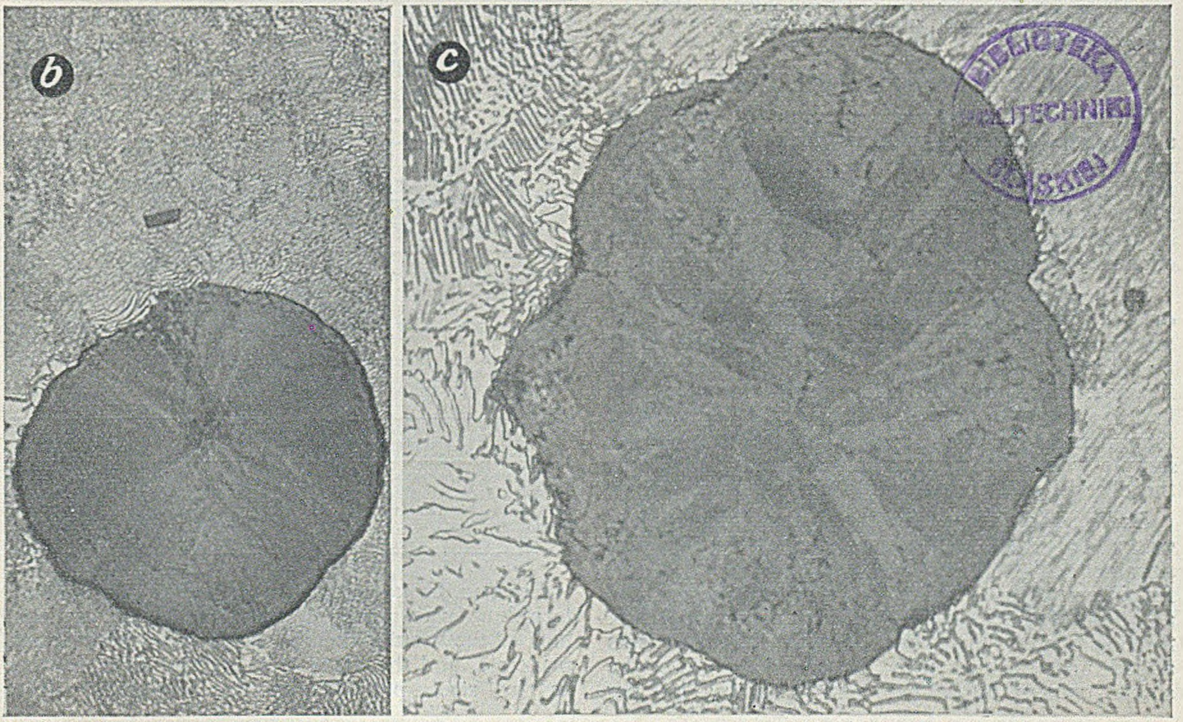


FIG. 4.—*Structure of S.-g. Clover-leaf Bar, Tensile Strength 51 to 52 tons per sq. in. (a) Unetched ×100; (b) Etched ×750, and (c) Etched ×1,500. The latter show a Graphite Nodule in a Matrix of Pearlite.*



H.F. Furnace Production of S.-g. Cast Iron

to 0.25; Mn, 0.4 to 0.6; S, 0.06 (max.); and P, 0.04 (max.) per cent., made up as follows:—

Charge material.	Percentage	Weight, cwt. qr. lb.
Mild steel	88.65	8 3 13
Carburizing compound	5.8	0 2 9
Ferro-silicon (45 to 50 per cent. Si)	5.55	0 2 6

Calculated Composition:—C, 3.48; Si, 2.70; Mn, 0.42; S, 0.06; and P, 0.02 per cent.

After preliminary tests to incorporate the carburizing compound with the charge to raise the carbon content to the required amount, it was found that the best method was to add all the carburizing medium on the furnace bottom, and to charge the furnace with the steel scrap in the normal manner. After melting and heating to approximately 1,460 deg. C. and stirring, the ferro-silicon was added and the metal was teemed. A wedge-test showed a coarse grey-iron fracture. Test results of this melt are given in Table I and the structure obtained is illustrated in Fig. 2 (*a*) and (*b*).

TABLE I.—*Test Results for the Synthetic Cast Iron.*

Percentage Chemical Analysis.—Total C, 3.20; Si, 2.70; Mn, 0.44; S, 0.060; and P, 0.019.
Tensile Test.—Ultimate stress, 17.7 tons per sq. in.
Microstructure.—Flake graphite, with a pearlitic matrix, as illustrated in Fig. 2.
Comments.—It was found that the carburizing effect was lower than calculated, but it will be appreciated that the total carbon content is influenced by temperature and the silicon content of the iron. The final silicon content indicated complete absorption of the element from the ferro-silicon addition. The carburizing compound was absorbed quietly and without visible flame, and resulted in a grey cast iron of good strength.

S.-g. Cast Iron from Synthetic Cast Iron

Having established the technique of producing a synthetic cast iron, all subsequent charges were made from additions of steel scrap and carburizing compound to give a base iron composition with 3.6 to 4.2 per cent. carbon and a silicon content of approximately 2 per cent. It was found that the efficiency of carburization was 55 to 60 per cent.

Melt.—The carburizing compound was placed on the furnace bottom and covered by the steel scrap so that a maximum carbon absorption could be effected. The temperature of the metal in the furnace, taken with an immersion pyrometer, was first increased to approximately 1,500 deg. C. and then reduced to 1,440 deg. C. before tapping. A sample was taken to represent the base metal, and the charge was teemed into a heated ladle.

Ladle Additions.—The magnesium/nickel alloy was added in the usual manner, and the slag was skimmed off. (A test-bar was cast at this stage, for interest, to examine the structure before the addition of the inoculant.) An addition of 7½ lb. ferro-silicon (75 per cent. Si) as inoculant was added and rabbled into the metal to raise the silicon content by 0.5 per cent. (assuming 100 per

TABLE II.—*Tests on the Base Iron and S.-g. Cast-iron Test-bars.*

Chemical analysis (per cent.)	Base iron.	Treated with Mg only (no inoculant).	Treated with Mg Fe-Si inoculant (clover-leaf bar).
	Per cent.	Per cent.	Per cent.
Total C	3.93	3.90	3.53*
Gr	—	2.26	2.81
Combined C	—	1.64	0.72
Si	2.07	2.06	2.60
Mn	0.42	—	0.43
S	0.056	—	0.006
P	0.017	—	0.017
Ni	—	—	1.42
Mg	—	—	0.15
Type of cast iron ..	Grey	Mottled	S.-g.

* Decrease in total carbon with increase of silicon from inoculation.

Physical Tests.

Base Iron—Tensile .. .. 15.0 tons per sq. in.
Microstructure .. Coarse graphite flakes in pearlitic matrix.

Spheroidal-graphite Cast Iron (Clover-leaf Bars).

Condition.	Yield stress, tons per sq. in.	Ult. stress, tons per sq. in.	Elongation, percentage on 2 in.	Brinell hardness.
As-cast ..	(1) 40.7	52.3	4	290
	(2) 39.8	50.9	3	285
Annealed ..	(1) 27.0	35.5	14	185
	(2) 27.2	35.1	16	180

Microstructure.—The test-bar poured after the addition of the magnesium alloy only (without addition of ferro-silicon inoculant) was mottled, but contained nodules of graphite. The bar was stripped when hot and showed a martensitic matrix (Fig. 3). The structure of the clover-leaf test-bar, having a tensile strength above 50 tons per sq. in. showed that the graphite was completely spheroidal in a groundmass of finely-dispersed pearlite, as shown in Fig. 4 (*a*), (*b*) and (*c*). After annealing for 3 hr. at 925 deg. C. followed by 5 hr. at 700 deg. C., the pearlite was replaced with a ferritic structure, with secondary graphite surrounding the original nodules. This structure is illustrated in Fig. 5(*a*); an unusual structure of a graphite nodule showing markings of roughly hexagonal shape is shown in Fig. 5(*b*). The markings are evidently related to the crystal structure of the graphite.

cent. efficiency). A single test-bar and two clover-leaf blocks were cast, and the remainder of the metal in the ladle (at a temperature of 1,380 deg. C.) was cast into the prepared moulds for special castings. A top-pouring ladle was used, with hand skimming. Tea-pot ladles were used subsequently.

TABLE III.—*Typical Example from a Mild-steel Charge.*
Charge.—Mild-steel scrap, 89.5; carburizing compound, 6.7; and ferro-silicon (45 to 50 per cent. Si), 3.8 per cent; *tapping temperature*, 1,460 deg. C.

Chemical analysis.	C	Si	Mn	S	P	Mg	Ni
Synthetic iron	4.20	2.10	0.57	0.060	0.023	—	—
Mg-treated iron plus ferro-silicon inoculant ..	3.50	2.95	0.57	0.005	0.022	0.09	1.62

Physical tests.	As-cast.	Annealed.
Yield stress, tons per sq. in.	—	24.5
Ultimate stress, tons per sq. in. ..	46.3	33.8
Elongation, percentage on 2 in. ..	3 to 4	15 to 17
Brinell hardness	295	180

Feeding Arrangement.—A comparison of feeding technique was made on these particular castings, half of the moulds incorporating the Connor-block principle, and the other half incorporating feeding as in steel practice—in this instance, direct

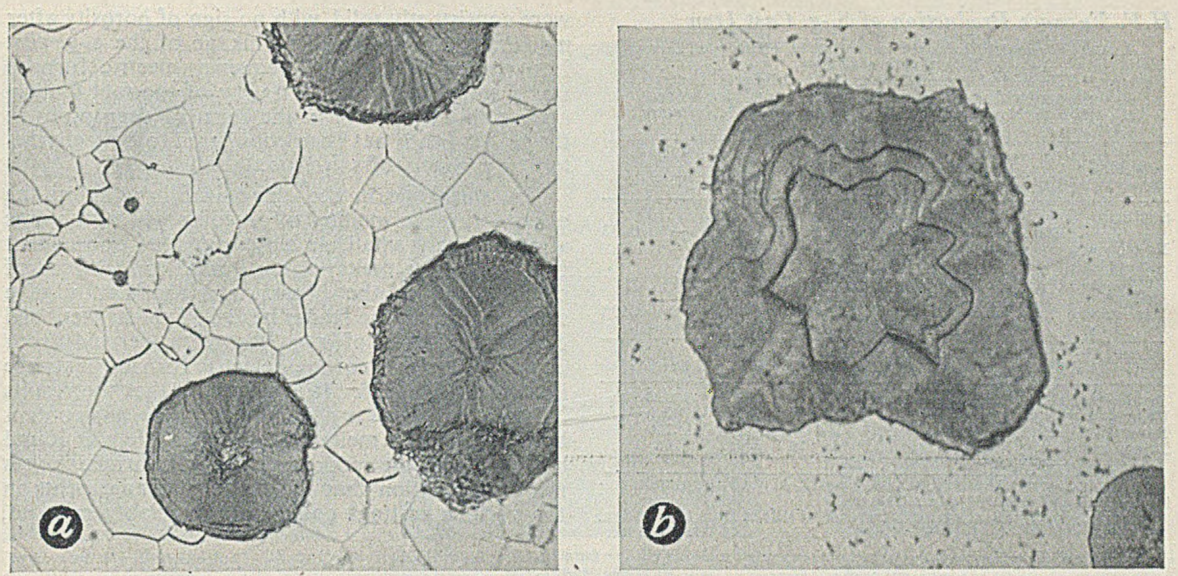


FIG. 5.—*Same Bar as Fig. 4 after Annealing; (a) General Structure and (b) Lightly-etched Graphite Nodule showing hexagonal markings; both ×750.*

feeding. It was generally found that castings with Connor-block feeder heads as compared with direct feeder heads gave improved results as regard smooth solid surfaces, probably due to the better skimming provided by the thin ingate of the Connor-block feeder (this is illustrated in Fig. 6). Actually, feeding arrangements for various castings vary appreciably and necessitate individual consideration (such as adopting a side feeder incorporating the whirlgate principle) whilst castings of very uniform section require only simple feeding arrangements. Test results for this series are quoted in Table II and illustrated in Figs. 3 to 8.

In view of the good results obtained, many subsequent melts were made from mild-steel charges in a normal routine manner with no difficulties, and a wide range of castings was made. Some typical results are shown in Tables III and IV. Castings made by the process described are shown in Fig. 7.

Shrinkage Characteristics of Clover-leaf Blocks

A feature of the clover-leaf blocks cast from electric-furnace iron was the very small volume of shrinkage cavity present in the feeder heads as compared with those from cupola-melted metal, whilst, in all the electric-furnace heats, the sectioned bars

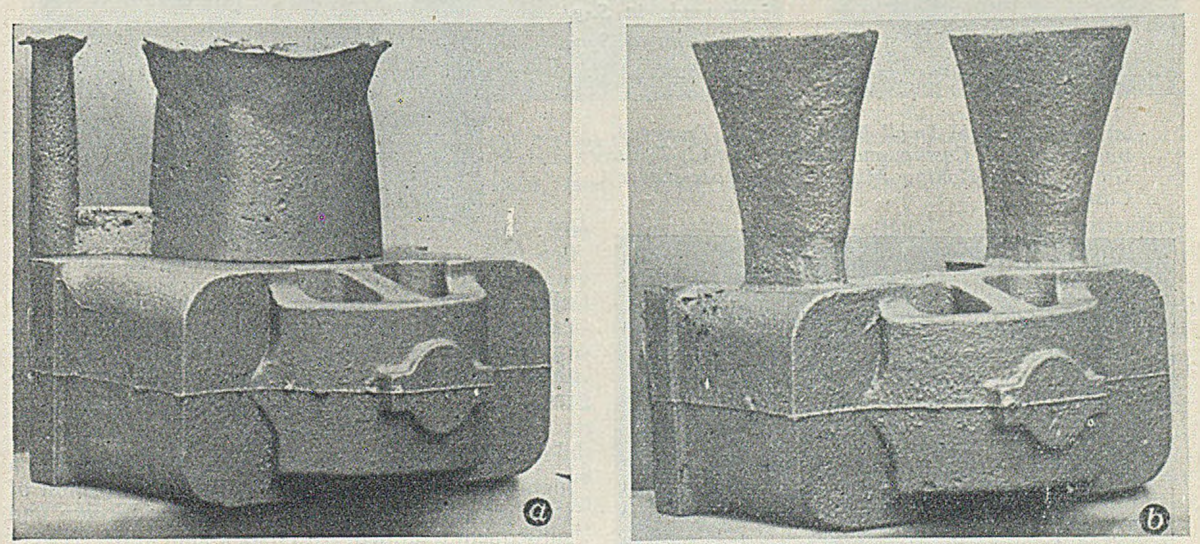


FIG. 6.—*(a) S.-g. Iron Casting with Connor-block Feeder Head (good, smooth surface) and (b) S.-g. Iron Casting of same design made with Direct Feeder Head (rough surface, with defects).*

H.F. Furnace Production of S.-g. Cast Iron

TABLE IV.—*Metal Produced from 4 per cent. Silicon-steel Scrap Diluted with Mild Steel.*

Charge.—Silicon-steel scrap*, 48.8; mild-steel scrap, 45.0; carburizing compound, 6.0; and ferro-silicon (45 to 50 per cent. Si), 0.2 per cent.; *tapping temperature*, 1,470 deg. C.

Chemical analysis.	C	Si	Mn	S	P	Mg	Ni	Al
Synthetic iron	3.61	1.87	0.19	0.035	0.017	—	—	0.03
Mg-treated iron plus ferro-silicon inoculant	3.37†	2.34	0.20	0.002	0.016	0.078	1.45	0.03

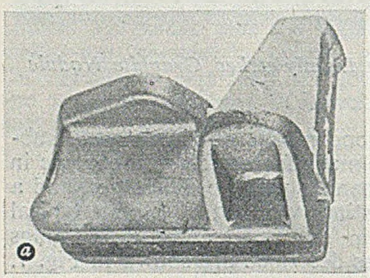
Physical tests.	As-cast.	Annealed.
Yield stress, tons per sq. in.	—	22.3
Ultimate stress, tons per sq. in. ..	47.4	30.5
Elongation, percentage on 2 in. ..	4 to 4½	21.0
Brinell hardness	276	165

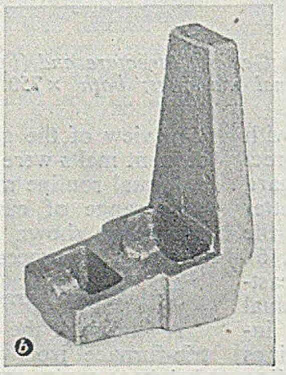
* C 0.08, Si 4.04, Mn 0.12, S 0.008, P 0.017, Al 0.45 (the aluminium is practically eliminated after melting).

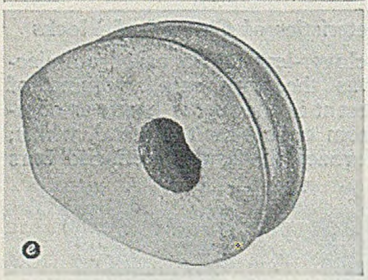
† Decrease in total carbon with increase of silicon from inoculation.

were consistently solid, with no sign of porosity after machining. The small shrinkage of the s.-g. cast iron melted in the high-frequency electric furnace was a surprising feature, in view of the fact that an appreciable shrinkage in the form of deep pipes in the feeder heads has been considered to be a characteristic property of s.-g. iron.[1]

The shrinkage in the clover-leaf head from the electric furnace melting of Swedish white iron was also relatively small, as stated, and all subsequent high-frequency melts of s.-g. cast iron clover-leaf blocks from synthetic cast iron consistently gave small cavities in the feeder heads. Typical sectioned clover-leaf heads of s.-g. cast iron derived from cupola and high-frequency electric furnace heats are illustrated in Fig. 8. It is suggested that the results indicate that there is a difference in the gas content between the two melts of s.-g. irons. It was found however, that the reduced clover-leaf shrinkage was not an indication that the feeding arrangements in the various castings could be appreciably reduced,







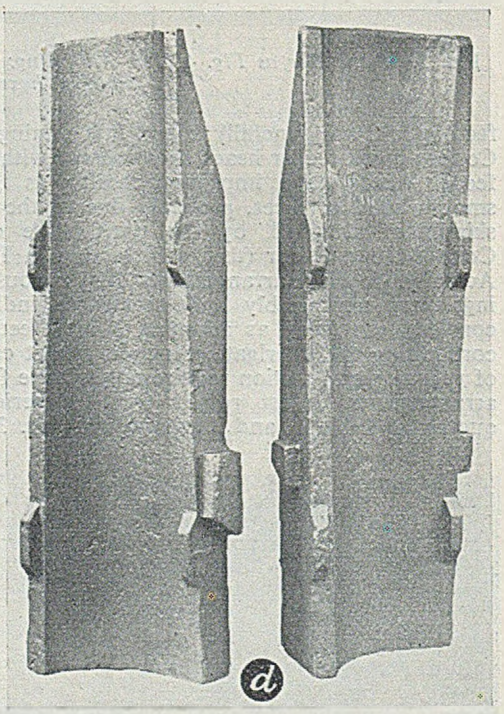
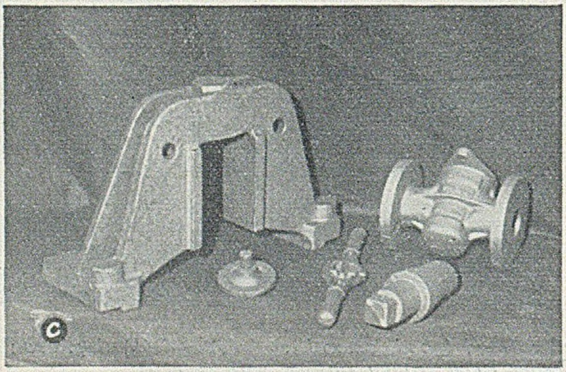


FIG. 7.—*Various Castings made in S.-g. Iron from a Synthetic Base.*

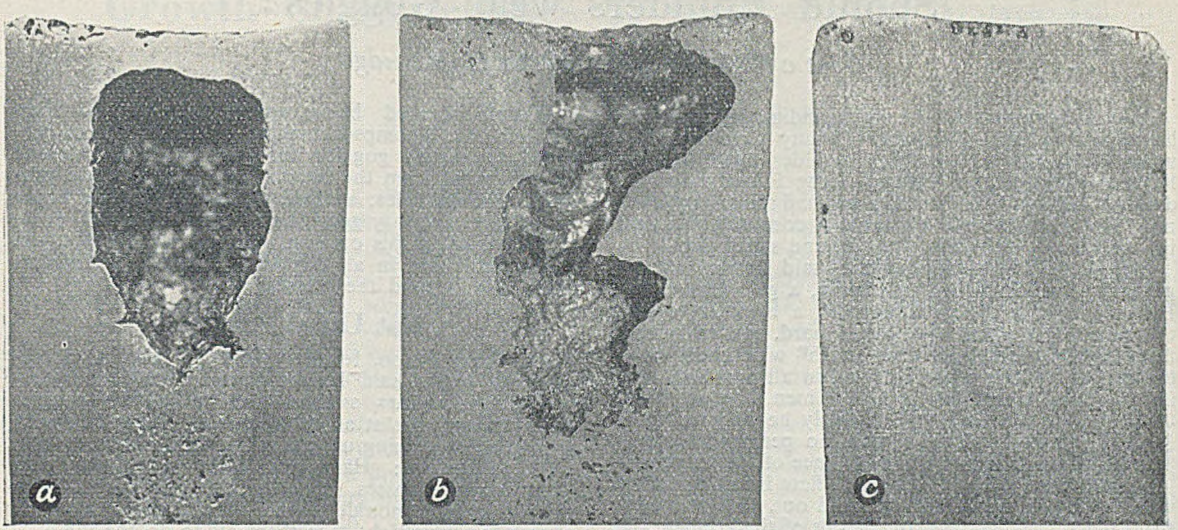
(a) Large and (b) Small Brackets for a Tramway Bogey; (c) Mill Casting and Valve Parts; (d) Twist Guides for a Rolling Mill and (e) Rope-sheave Casting.



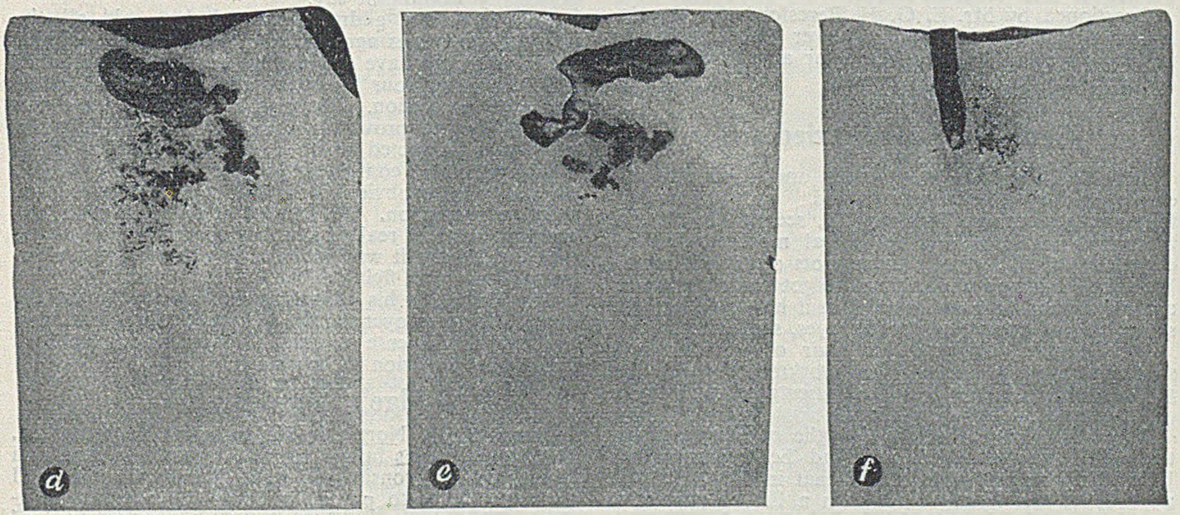
although the shrinkage in the feeder heads of the castings was much less than that found with cupola-melted iron, particularly with direct feeding on to the casting, the amount varying with different castings.

Summary

Tests have shown that it is possible to produce a high-grade of s.-g. cast iron by the carburization of steel scrap in a high-frequency electric furnace and subsequent treatment with magnesium alloy. A very high level of tensile strength (up to 52 tons per sq. in.) is obtained in the cast condition, and elongation



(*a*) and (*b*) Examples of Open Pipes from Cupola Heats, and (*c*) Synthetic Cast-iron Base Metal, showing the absence of Shrinkage Cavities.



(*d*) Shrinkage Cavities from H.F., Melt with Swedish Pig-iron Charge, and (*e*) and (*f*) Examples showing the Small Area of Cavities from Synthetic Nodular Cast Iron made in the H.F., furnace.

FIG. 8.—*Sectioned Clover-leaf Feeder Heads showing Varying Amounts of Shrinkage.*

values from 15 to 21 per cent. after annealing. The addition of magnesium alloy can be reduced with, comparatively, low-sulphur charges, and the recovery of magnesium is slightly greater than that obtained from cupola-melting metal. Manganese and phosphorus contents can be kept at the required low values with the use of suitable steel scrap. The shrinkage in the clover-leaf feeder heads is extremely small as compared with the large voids found in heads from cupola melts. The castings are appreciably solid, with good machining characteristics. Although the overall cost of the process is slightly higher than in cupola melting, owing to the more expensive operational costs, there was a marked improvement in the metallurgical characteristics of the metal as regards strength, ductility, solidity, and freedom from defects. The process outlined could be particularly attractive to foundries having a supply of low-manganese and silicon-steel scrap.

The Authors wish to express their thanks to Mr. W. W. Braidwood and Mr. A. D. Busby, of the Mond Nickel Company, for their interest and encouragement during the progress of the work, and to Mr. R. A. Owen-Barnett for assistance in the preparation of the photomicrographs. Thanks are due to Mr. G. H. Latham, LL.D., J.P., chairman of the Whitehead Iron & Steel Company, Limited, for permission to publish the article.

REFERENCE

[1] Braidwood & Busby, FOUNDRY TRADE JOURNAL, 1949, 88 pp. 327-334.

Should Moulders wear Goggles?

Not a Custom of the Trade says Judge

A case important to the ironfounding industry was heard at the West Bromwich County Court recently when James Ernest Rowley, a moulder, aged 40, sued William Cross & Son, Limited, Lyng Foundry for £30 damage for personal injuries he had received to his right eye when he was knocking a core out of a casting, and a piece of metal flew off and struck him.

Mr. H. G. Talbot, for plaintiff, said Rowley was engaged in "knocking out" a casting, a gear box casing. He had to knock the casting with a hammer to eject the sand core, which was baked hard, and to remove fragments of metal known as "flash" which adhered to the casting. Pieces of flash fly off in all directions, and is constitutes a real danger to the men who are doing the work, he declared. Fortunately he had recovered from the injury and there were no permanent effects. The claim was based on the negligence of the employers.

Rowley, in evidence, said flash flew in all directions when a casting was being knocked out. He was away from work for five days as a result of the accident. He had been a moulder since leaving school and had worked at four different firms.

Questioned by Mr. E. G. H. Beresford, for the defendants, plaintiff said he had never had anything to protect his eyes. He did not wear any protection at his present place of employment.

Sample Goggles Tried out

Samuel Thompson, a moulder and shop steward, employed by defendants, said he approached the management on February 19, seeing Mr. Sutton, the works manager because several moulders had received minor eye injuries from spots of molten metal. We thought it was about time we got some protection against these burns, and asked him if he would provide some kind of protection for the eyes, said witness.

Two sample goggles and a pair of steel rimmed spectacles were provided. The workmen rejected the goggles as unsuitable, but the glasses were tried by a moulder and found satisfactory.

Asked by Mr. Talbot whether the question of protection of moulders generally had been brought up before the accident, witness said that in May, 1951, he approached the management with a list of protective clothing, and he thought this included goggles.

Questioned by Mr. Beresford, witness said he had been employed by the defendants as a moulder for 27 years.

Mr. Beresford: You are a trade union official and have a fair knowledge of what goes on in the industry, and is it not the practice for moulders to wear goggles?—Not at William Cross, Limited.

Not anywhere?—I couldn't answer that, sir.

Mr. Sutton produced two types of goggles and a pair of spectacles, and asked if the difficulty was that the men did not decide what they wanted—They did, the spectacle type.

Samuel Sutton, works manager, giving evidence for the defendants, said there were 90 to 96 moulders at the foundry, and in the whole of 40 years there he was not aware of a similar accident. To knock out a casting took half a dozen to a dozen sharp taps with a hammer.

Mr. Beresford: How much flash comes off during that knocking out?—I wouldn't like to say.

Have you ever in your working life known moulders wear goggles?—Not at William Cross, Limited.

Witness recalled being approached by the shop steward, Mr. Thompson, asking if the firm were prepared to supply goggles for the moulders catching molten metal from the cupola, and pouring. He provided three samples; a visor, which covered the whole of the face, ordinary goggles, and open-sided steel spectacles, which, in his opinion, were no use for the job. If the flash flew in all directions it would get underneath and around the glasses.

Not Usual Practice

Mr. Percy Aston, formerly foundry foreman at defendants' works, said he had been in the foundry industry for 35 years, and he failed to see that goggles would be any use at all to moulders. Spectacles were a handicap, steaming up due to heat and sweat.

Mr. Beresford: Have you ever known moulders wear goggles, glasses, or other eye protection?—No, I have known moulders who are supposed to wear glasses for their sight take them off to do the job.

Are any types of goggles or glasses of use?—I, personally would not say.

Mr. Beresford, addressing the Judge, said all the plaintiff's witnesses agreed that it was not the practice for moulders to have eye protection. Plaintiff, himself, had worked at four foundries and said he had never had eye protection. In my submission, what the plaintiff has to prove, to succeed, is either that the defendants neglected to do something that was commonly done and commonly provided by employers, or the risk was so obvious it would be folly not to provide eye protection. We know that not until after the accident was any real request for eye protection made, then apparently it was because of splashes of molten metal rather than flying metal.

Mr. Talbot, in his address, submitted that it was the duty of the employer to take all reasonable precautions, and that in the case in question that could have been taken, the provision of spectacles.

Judge's Summing up

Judge R. H. Norris, in his summing up remarked, Negligence means failure to take reasonable care, and when you are considering what is reasonable care, I think you have to pay attention to the common standard. If a person conforms to the common standard then it seems to me there may be exceptional cases, but taking it by and large he is exercising reasonable care.

The question was what element of risk there was to the moulders when they were knocking out. It was work which was being done every day by a large number of workmen all over the country, and as far as the Judge knew, from what he heard in the case, it was common practice to do that work without any form of eye protection.

The Judge added: As far as I can see, almost invariably the people who are engaged in it are without any form of eye protection. There is an element of risk, but it seems to me it is so small that the plaintiff, who has been engaged in this job for so long, and the other witnesses who have been engaged in the job also for long periods can tell me of no previous accident of this kind.

He was not going to say that the defendants had been negligent because they had failed to take some steps which others, presumably good employers, had not thought fit to take.

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

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

(*Continued from page* 287)

EXPERIMENTAL WORK ON GROWTH PHENOMENA

Most of the experiments to be described were carried out on ingot-mould irons. There were three reasons for doing this. First, some unusual structures and unexpected growth values had been observed in growth tests carried out on ingot-mould irons by Heselwood and Pickering.[15] Secondly, the large graphite flakes in ingot-mould irons promote greater depth of oxide penetration and provide larger areas of oxidized metal under oxidizing conditions than do castings with a finer graphite structure. This assists in examining oxidation products and other structures in the iron. Thirdly, the ingot-mould irons are not complicated by the presence of alloys. Unless otherwise stated, the tests were carried out on the ingot-mould irons of the compositions shown in Table I cast originally into blocks 6 by 4 by 30 in. long. All these irons contained coarse flake graphite in an almost entirely pearlitic matrix.

TABLE I.—*Ingot-mould Irons used for Experiments.*

No.	Composition, per cent.				
	T.C.	Si	Mn	S	P
3	3.52	1.32	0.61	0.082	0.066
4	3.84	1.61	0.66	0.065	0.21
7	3.86	1.37	0.98	0.063	0.116
11	3.69	1.64	0.46	0.089	0.099
13	4.29	1.85	0.83	0.054	0.047

Oxidation and Growth at Sub-critical Temperatures

Many investigators have reported growths at temperatures below 600 deg. C. Campion and Donaldson[20] have measured growths, changes in weight, and the effect on mechanical properties due to repeated heating and constant temperature heat treatment at 450 and 550 deg. C. Growth was attributed to decomposition of the combined carbon. Sipp and Roll[21] examined the effect of stressing cast iron in superheated steam at 450 deg. C. In growth tests in air, Piwowarsky and Bornhofen[22] concluded that growth does not occur in a laboratory test at less than 550 deg. C., though growth can occur in service at 200 deg. C. They believed that the vibrations incurred in service enhanced growth even at 200 deg. C. Scheil[23] made a study of the oxidation of test-pieces varying from 5 to 100 mm. dia. after up to 3,700 hrs. at 600 deg. C., and gave many illustrations of the oxidation products formed. In a 43-day growth-test at 500 deg. C. on a flake-graphite iron of 18-ton tensile in which the linear growth was 0.163 per cent., the present Author[24] has observed lightly-etching oxidation products associated with the graphite flakes at the extreme edge of the sample.

As a check on the oxidation products resulting from long exposure in air at sub-critical temperatures, some tests were carried out on ingot-mould irons Nos. 4 and 7. Samples 2 by 2 by 2 in. of irons Nos. 4 and 7 were heat-treated in an electrically-heated muffle furnace for 30 and 60 days at 500 deg. C. Structural changes took place over a depth of ¼ in., the matrix consisting of spheroidized pearlite and the extreme edge being almost entirely ferritic in the vicinity of the graphite flakes (Fig. 7). There were two notable features about the graphite flakes near the surface. Apart from the extreme edge, the graphite flakes were intact and surrounded by a dark layer of compact oxide adjacent to the flakes, and an outer envelope of a constituent which was boundary-etched in picric acid. When, however, the specimens were afterwards etched in ammonium persulphate, the envelope was coloured a yellowish brown, and also it bore black markings resembling grain boundaries (Fig. 8). The dark oxides represent an intense oxidation of the matrix at the graphite/matrix interface, and the envelope probably represents oxidation of the silicon in solution in the matrix to silica or to complex silicates in a very fine form, as the oxygen diffuses into the metal. Irons which were afterwards annealed for shorter periods at 700 deg. C. had similar structures when etched in picric acid

FIG. 7.—*Ingot-mould Iron No. 4 after 60 days at 500 deg. C. in Air. Edge of specimen,* × 60; *etched in 4 per cent. Picral and Ammonium Persulphate.*

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

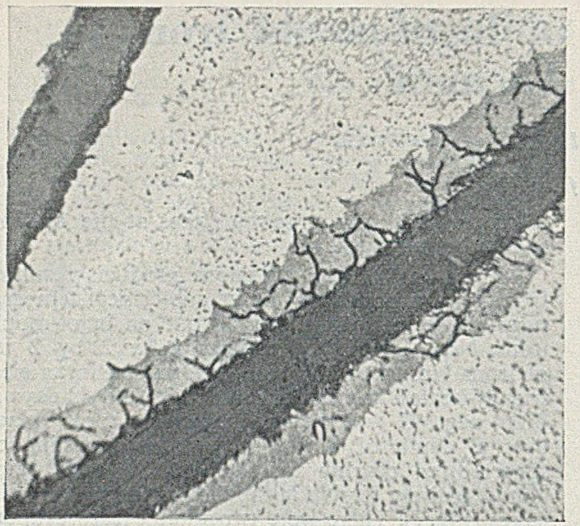


FIG. 8.—*Ingot-mould Iron No. 4. Same as Fig. 7, but* × 800; *etched in 4 per cent. Picral and Ammonium Persulphate.*

alone. The black lines within the envelope appeared to be constituents comparable in thickness with the cementite plates in pearlite. They were probably oxides, like the black bands on either side of the graphite flakes.

An unusual structure of "white flakes" was obtained in specimens which were severely oxidized by annealing at 700 deg. C. for 30 days in air. On the extreme edge, the graphite had been removed, and the cavities filled with oxide, but just away from the edge the cavities contained a white metallic constituent, which remained white even when the remainder of the matrix was deeply etched. The identity of these white flakes was not definitely established, but it appeared to be ferrite. In Fig. 9, the white constituent is seen alongside graphite and the oxidized layers already described. Pearson[4] has explained its presence in repeated heating tests as precipitation of ferrite caused by the reduction by the graphite of the already-formed metallic oxides. Hallett[7] also observed the white flakes in hematite, low Ni/Cr irons and in austenitic irons, but not in Silal. Their maximum development was attained in constant-temperature annealing in air at 850 deg. C., though it was also observed in samples oxidized at 750 deg., 950 deg. and 1,050 deg. C. He suggested that they may be the result of diffusion of the less oxidizable constituents of the matrix into spaces left by the oxidized graphite flakes. If the constituent is ferrite, it is not clear why it should remain unoxidized in such oxidizing conditions, whether it be formed by precipitation or by diffusion from the surrounding matrix.

White flakes have also been observed in samples of ingot-mould irons subjected to repeated heating tests to 900 deg. C., but in this case their formation appears to be caused by the envelopment of the matrix in flake form by diffusing oxides. Reference to this (Figs. 25 to 29) will be made later in the Paper.

Repeated Heating in Vacuum

Most of the information reported in the literature on growth due to repeated heating in vacuum is misleading, since, with the exception of Rocquet and Olette, the investigators have not obtained a satisfactory vacuum by present standards, and the methods used have probably been ineffective to prevent circulation of air through the apparatus. As the following experiments show, even a slight amount of oxidation before the repeated heating tests can profoundly affect the amount of growth that takes place. These tests were carried out in a carefully-maintained vacuum which ensured that any oxidation effects were completely avoided. The vacuum was produced by a mercury diffusion pump, backed by a rotary pump and the pressure did not exceed 10^{-3} mm. of mercury.

Experiments One, Two and Three

Cylindrical test-pieces 2 in. long by 0.5 in. dia. of ingot-mould iron No. 3 were subjected to 100 cycles of heat-treatment between 650 and 900 deg. C. in vacuum. The complete cycle, 650—900—650 deg. C. took 1½ to 2 hrs. The materials tested were:—3C1: iron No. 3 in the as-cast condition; 3V1: iron No. 3 previously annealed for 500 hrs. at 700 deg. C. in vacuum; and 3A1: iron No. 3 previously annealed for 500 hrs. at 700 deg. C. in air. The overall dimensions of the cylinders were measured with a micrometer before and after treatment. The annealing treatment at 700 deg. C. made the iron almost completely ferritic, so that negligible amount of growth could be attributed to decomposition of combined carbon in the matrix. The growths obtained are given in Table II. In a repeat experiment, as-cast and air-annealed samples were measured and weighed before and after heat-treatment. These results are also included in Table II.

The microstructures of the vacuum-annealed

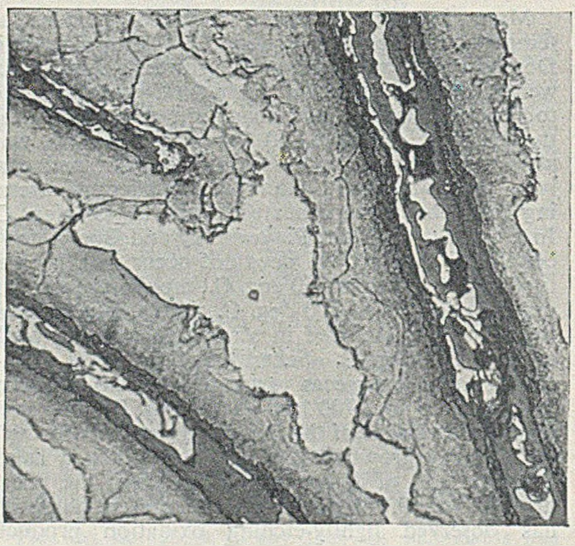


FIG. 9.—*Ingot-mould Iron No. 13 after 30 days at 700 deg. C. in Air, showing formation of "White Flakes";* × 800; *etched in 4 per cent. Picral.*

TABLE II.—*Growths after* 100 *Cycles* 650—900—650 *deg. C. in Vacuum and in Argon.*

Experiment.	Specimen.	Increases, per cent.			
		Length.	Diameter.	Volume.	Weight.
1 in vacuum	3 CI as-cast ..	9.7	10.0	32	Not measured
	3 VI vacuum-annealed	8.7	8.6	28	
	3 AI air-annealed	1.8	2.0	5.6	
2 in vacuum	3 C2 as-cast ..	6.5	6.8	21.3	−0.0155
	3 A2 air-annealed	1.2	0.5	3.6	−0.0376
3 in argon	11 Cl as-cast ..	11.2	11.8	39.2	+0.022
	11 A1 air-annealed	1.2	1.0	3.4	−0.055

sample 3 V1 and the as-cast samples 3 C1 and 3 C2, in which the growths varied from 21 to 32 per cent., all had a "fluffy" constituent growing from the sides and ends of the graphite flakes. There were also areas within the matrix where a new constituent or cracks had appeared (Figs. 10 and 11). There was some pearlite in all the specimens. In specimens 3 A1 and 3 A2 which, however, had been previously annealed in air, the growths were only 5.6 and 3.6 per cent. respectively, and the structure did not differ appreciably from the original annealed structure. A small amount of pearlite that had formed was mainly associated with the graphite flakes (Fig. 12).

Similar repeated heating tests, 100 cycles, 650-900-650 deg. C., were carried out on ingot-mould iron No. 11 in pure, dry argon. Specimen 11 C1 was as-cast and 11 A1 had been previously annealed in air for 500 hrs. at 700 deg. C. to make it ferritic. The argon was passed through a drying and purifying train of chromous chloride, soda asbestos and phosphorus pentoxide before reaching the furnace. The growths and weight changes are given in Table II. The microstructures were

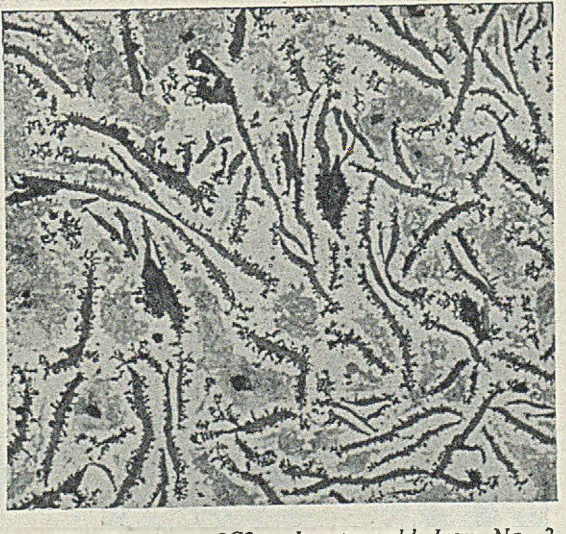


FIG. 10.—*Specimen* 3C2. *Ingot-mould Iron No.* 3, *As-cast, after* 100 *heatings* 650-900-650 *deg. C. in Vacuum, showing* 21.3 *per cent. volume Growth;* ×60; *etched in* 4 *per cent. Picral.*

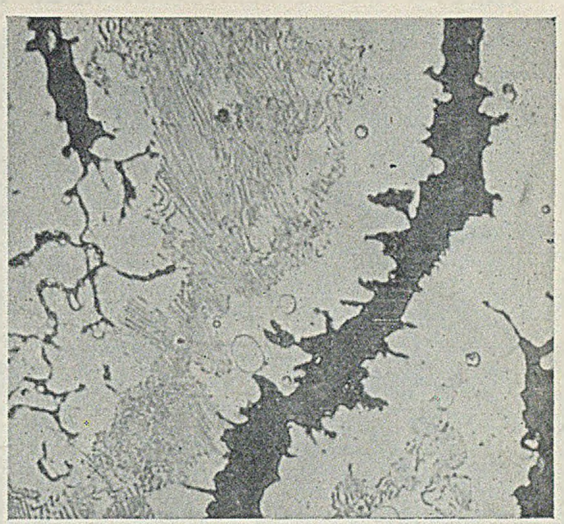


FIG. 11.—*Specimen* 3C2; *same as Fig.* 10, *but* ×600; *etched in* 4 *per cent. Picral.*

similar to the corresponding samples of iron No. 3 repeatedly heated in vacuum. Again, an appreciable growth was obtained by repeatedly heating the as-cast material, but growth was significantly reduced by previously annealing in air. Though different materials were used, some importance may be attached to the fact that the growth of the as-cast material was greater in argon than in vacuum, and yet the growth of the air-annealed specimens was less in argon than in vacuum. This suggests that argon, though an inert gas, may in some cases enhance growth during repeated heating.

Experiment Four

The previous experiments provided strong evidence that appreciable growth could take place when cast iron was repeatedly heated and cooled through the critical range with all oxidizing influences eliminated. It was not known if, and to what extent, the elements other than iron and graphite present in the cast iron could contribute to the growth, and so an attempt was made to cast, in vacuum, an ingot of pure iron and carbon. Hilger iron and electrode graphite were melted in an alumina crucible in a platinum-wound furnace and allowed to solidify in the crucible. The 260 gm. ingot so obtained was then re-melted in the vacuum furnace and allowed to cool slowly. During the re-melting in the vacuum furnace, the ingot bridged, causing overheating of the molten metal underneath and reduction of the alumina crucible. According to a spectrographic analysis, the final ingot, No. 31/5C, had picked up 1.8 per cent. aluminium. In a repeat melt, bridging was avoided and the pure iron/carbon ingot was numbered 15/7C. Each ingot was sectioned longitudinally into four, and one quarter of each was annealed in air for 200 hrs. at 700 deg. C. and numbered 31/5A and 15/7A.

The graphite structures of the ingots varied appreciably in coarseness, each containing

FIG. 12.—*Specimen* 3A2. *Ingot-mould Iron No.* 3 *annealed* 500 *hrs. at* 700 *deg. C. in Air and then* 100 *heatings* 650-900-650 *deg. C. in Vacuum*—3.6 *per cent. volume Growth;* ×60; *etched in* 4 *per cent. Picral.*

under-cooled graphite, the Fe/C ingot 15/7C also containing kish graphite. Cylinders 1 in. long and 0.375 in. dia. were machined from as-cast and annealed quarters of each ingot, and also from an as-cast austenitic iron, X984/C, of Ni-Resist composition. Each cylinder weighed about 12 gm. All five specimens were supported in a pure iron crucible and subjected to 100 heating cycles, 650-900-650 deg. C. in vacuum. The growths obtained are given in Table III. The growths must be

TABLE III.—*Growths of Fe/Al/C and Fe/C Specimens after* 100 *Cycles* 650—900—650 *deg. C., in Vacuum*

Specimen.	Increases, per cent.		
	Length.	Diameter.	Volume.
31/5C Fe/Al/C as-cast	16.0	16.0	55.8
31/5A Fe/Al/C air-annealed ..	0.2	0.9	2.0
15/7C Fe/C as-cast	4.2*	4.7*	14.2*
15/7A Fe/C air-annealed	1.8*	2.8*	7.6*
X984/C Austenitic as-cast ..	0.4	0.5	1.6

* Specimens had a very heterogeneous microstructure and many deep cracks had appeared.

regarded only as approximate, since all the ingots except 31/5A were distorted. However, the following observations were made:—

(1) The Fe/Al/C specimen, 31/5C, had grown more than any other sample tested in vacuum in this or the previous tests.

(2) The growth in the pure Fe/C specimen was less than one-third of the growth of the Fe/Al/C specimen.

(3) At the end of the test, the Fe/Al/C specimen had a rough, black surface, the remaining samples being slightly roughened, but grey.

(4) Pre-annealing in air had restricted growth.

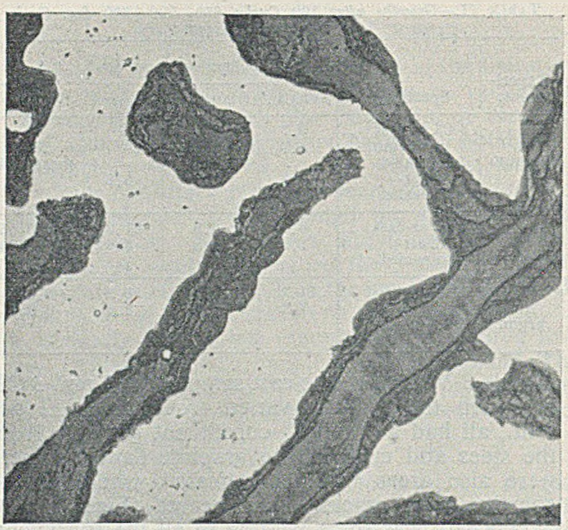


FIG. 13.—*Specimen* 31/5C. *Fe/Al/C Alloy As-cast, after* 100 *heatings* 650-900-650 *deg. C. in Vacuum*—55.8 *per cent. volume Growth;* ×800; *etched in* 4 *per cent. Picral.*

(5) The as-cast austenitic iron, which did not pass through a critical transformation, had grown least.

Some microstructures of these specimens are illustrated in Figs. 13 to 16. The graphite in the as-cast Fe/Al/C specimen, 31/5C, was surrounded by large black areas occupying a substantial part of the section (Fig. 13). The constitution of these black areas has not been identified. In the specimen previously annealed in air, 31/5A, the graphite cavities were only slightly swollen, but the matrix contained particles distributed throughout (Fig. 14). The swelling of the graphite cavities of the Fe/C

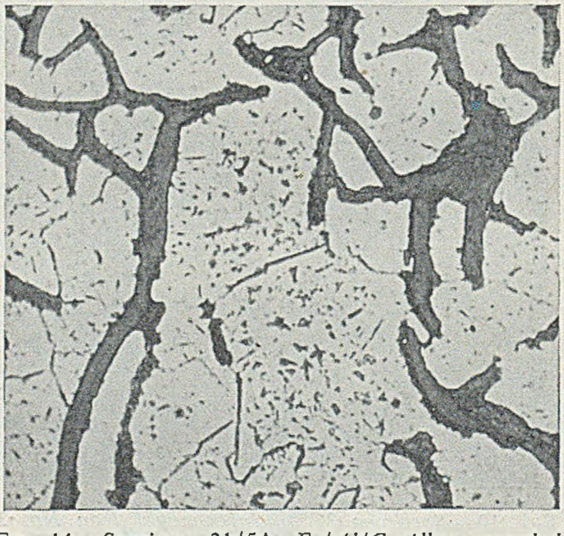


FIG. 14.—*Specimen* 31/5A. *Fe/Al/C Alloy annealed* 200 *hrs. at* 700 *deg. C. in Air, and then* 100 *heatings* 650-900-650 *deg. C. in Vacuum*—2.0 *per cent. volume Growth;* ×800; *etched in* 4 *per cent. Picral.*

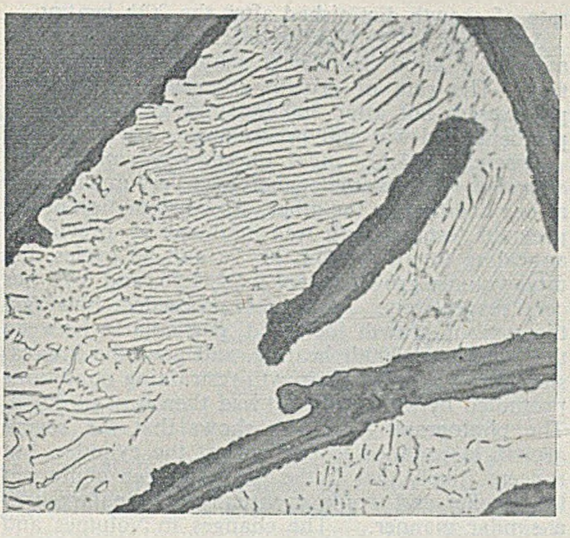


FIG. 15.—*Specimen 15/7C. Fe/C Alloy As-cast after 100 heatings 650-900-650 deg. C. in Vacuum—14.2 per cent. volume Growth;* ×800; *etched in 4 per cent. Picral.*

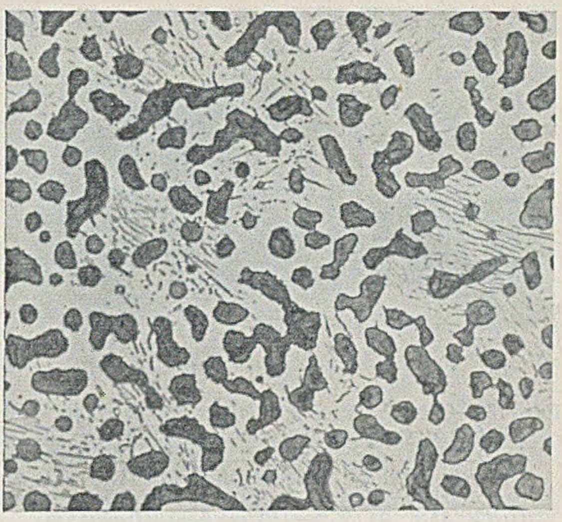


FIG. 16.—*Specimen 15/7C. Fe/C Alloy. Same specimen as Fig. 15 but different area and at* ×800; *etched in 4 per cent. Picral.*

specimen, 15/7C, depended upon the size of the graphite flakes. The large flakes had swollen less than in the Fe/Al/C specimen (Fig. 15), but in the under-cooled graphite areas the growth products were almost spheriodal (Fig. 16). The annealed Fe/C specimen had a similar structure to the as-cast specimen.

Experiment Five

In a further series of tests, the progress of growth due to repeated heatings was recorded and, for the as-cast Fe/Al/C specimen, the remarkable volume growth of 153 per cent. was obtained after 300 heatings, 650—900—650 deg. C. in vacuum. After subsequent annealing in air, further growth was prevented. Repeated heating was carried out on the as-cast Fe/Al/C and Fe/C materials, and on as-cast and annealed samples of ingot-mould iron 11, numbered 11C2 and 11A2 respectively. The cylindrical specimens were machined 1 in. long by 0.375 in. dia., but the Fe/C specimen, 15/7C2, broke during machining and was made 0.500 in. long by 0.375 in. dia. The test-pieces were periodically cooled to room temperature for measuring and weighing, so that the progress of growth could be recorded. The results are plotted in

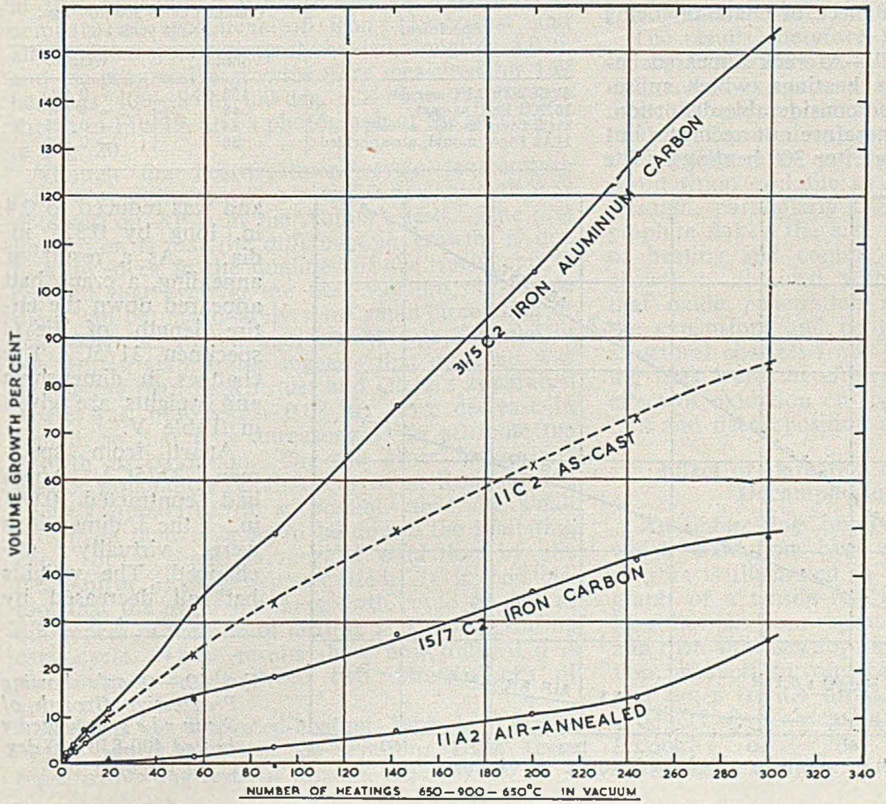
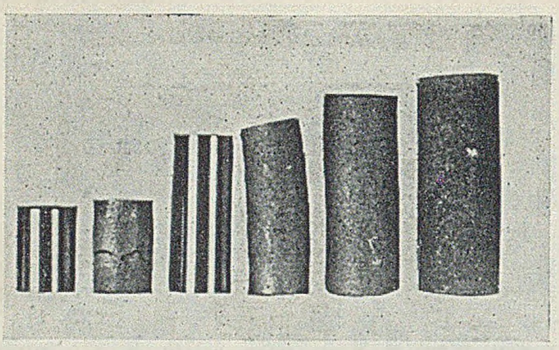


FIG. 17.—*Graph showing Progressive Growth of Four Samples repeatedly heated 650-900-650 deg. C. in Vacuum.*



(a) (b) (c) (d) (e) (f)

FIG. 18.—*Growth Specimens after* 300 *heatings*: 650-900-650 *deg. C. in Vacuum. Specimens*:—(*a*) 0.5 *by* 0.375 *in. dia.*; (*b*) *Fe/C*, 15/7C2—48 *per cent. Growth*; (*c*) 1 *by* 0.375 *in. dia.*; (*d*) 11A2—26 *per cent. Growth*; (*e*) 11C2—84 *per cent. Growth*; *and* (*f*) *Fe/Al/C*, 31/5C2—153 *per cent. Growth.*

Fig. 17 and the following observations were made:—

Specimen 31/5C2, *Fe/Al/C*.—Between the 90th and 142nd heating, the specimen began to bend and continued to do so for the remainder of the test. This specimen had grown at a uniform rate from the first heating and growth was continuing at the same rate even after 300 cycles, when the original volume had increased by 153 per cent. Its specific density had dropped from 6.8, before growth. to 2.7, and it behaved like a piece of chalk on being cut.

Specimen 15/7C2, *Fe/C*.—A crack appeared between the 20th and 56th heatings, which subsequently enlarged and caused considerable distortion. The measurements were therefore not accurate, but growth was still continuing after 300 heatings. The rate of growth diminished after the 20th heating.

Specimen 11C2, *ingot mould, as-cast*.—This remained a good cylindrical shape throughout the test. The rate of growth decreased as the test progressed, but after 300 heatings growth was 84 per cent. and was still proceeding.

Specimen 11A2, *ingot mould—previously air-annealed*.—The diameter increased very much more at one end than at the other. In confirmation of the previous tests, growth was inhibited by previously annealing in air. After 20, 56 and 90 cycles, the total volume growths were 0.78, 1.56, and 3.71 per cent. respectively. As the test proceeded, however, the rate of growth increased, particularly between the 244th and 300th heating, and gave the impression that the original growth-restraining conditions promoted by the air anneal had then broken down. The photograph (Fig. 18), shows that the severe growth is confined to one end of the cylinder, but it seems likely that if the test had been continued the smaller end would eventually have enlarged in a similar manner. The changes in volumes and weights due to the 300 heatings are given in Table IV.

As air annealing was shown in these and the previous tests to inhibit growth, the samples 31/5C2, 11C2 and 11A2 were subsequently annealed in air for 20 hrs. at 700 deg. C. and then machined to their original size (1 in. long by 0.375 in. dia.) and subjected again to 250 heatings in vacuum. The ingot-mould sample, 11C2 broke during machining and was reduced to 0.4 in. long by 0.375 in. dia. As a result of annealing, a crack had appeared down the entire length of Fe/C specimen, 31/5C2. The changes in dimensions and weights are given in Table V.

Apart from specimen 31/5C2, which had contracted 0.005 in., the dimensions were virtually unchanged. The weights had all decreased by

TABLE IV.—*Changes in Volumes and Weights due to* 300 *Heatings*, 650—900—650 *deg. C., in Vacuum.*

Specimen.	Change due to 300 heatings, per cent.	
	Volume.	Weight.
31/5C2 Fe/Al/C as-cast	153	+ 0.025
15/7C2 Fe/C as-cast	48	− 0.048
11C2 Ingot mould, as-cast ..	84	− 0.121
11A2 Ingot mould, air-annealed	26	− 0.495

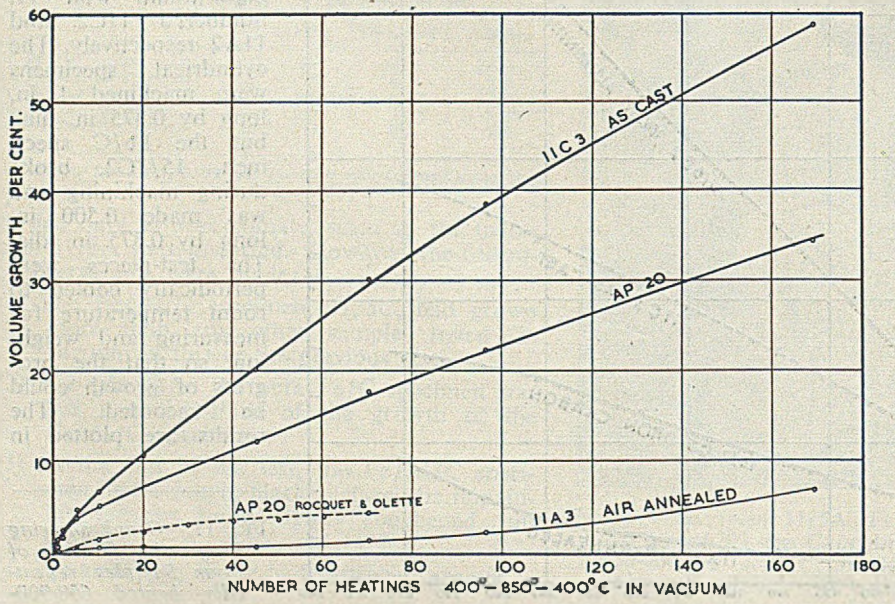


FIG. 19.—*Graph showing Progressive Growth of Samples repeatedly heated* 400-850-400 *deg. C. in Vacuum.*

from 0.37 per cent. to 1.72 per cent., due presumably to the loss of oxygen picked up during the air anneal at 700 deg. C.

Experiment Six

While these repeated heating tests were being

TABLE V.—*Changes in Dimensions and Weights of Specimens (treated as in Table IV) after Annealing in Air and then a Further* 250 *Heatings in Vacuum.*

Specimen.		Length, in.	Diameter, in.	Weight, gm.
31/5C2	Before	1.000	0.375	6.940
Fe/Al/C	After	0.995	0.374	6.920
11C2	Before	0.399	0.3745	2.794
Ingot mould, as-cast ..	After	0.398	0.374	2.746
11A2	Before	1.000	0.376	10.597
Ingot mould, annealed ..	After	1.000	0.377	10.486

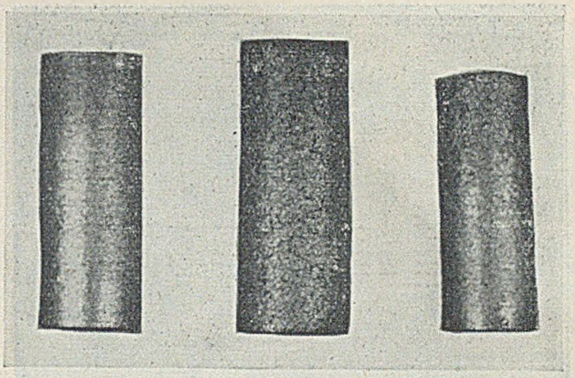
carried out, the work by Rocquet and Olette[13] was published, and it appeared that they had carried out their tests in a good-quality vacuum, where a pressure of 10^{-3}mm. of mercury was maintained, probably very similar to that employed in the Author's tests. By arrangement with Mr. Olette, a piece of their cast iron AP20 was sent to the B.C.I.R.A. laboratories and, as a check, a repeated-heating test was carried out, using a temperature cycle 400—850—400-deg. C., the same as used originally by Rocquet and Olette.

The composition of AP20 was as follows:—T.C., 3.04; G.C., 2.63.; C.C., 0.41; Si, 1.60; Mn, 0.60 and P, 0.14 per cent. The total-carbon content was lower, and the graphite structure less coarse, than in the ingot-mould irons 3 and 11. By way of comparison, specimens of iron 11—as-cast and air-annealed were repeatedly heated alongside AP20, and the progressive growths were measured for 169 heatings 400—850—400-deg. C. The results are shown in Fig. 19, and a photograph of the specimens in Fig. 20.

Though the heat-treatment cycle temperature ranges were the same, a much larger growth was obtained on AP20 in the Author's tests. The first impression is that the difference in growths is due to differences in the qualities of the vacua. It is realized that even in the best vacuum obtainable there will be unavoidably some small circulation of air. The fact that a high growth was obtained in the Author's apparatus suggests that more air was circulating than in Rocquet and Olette's apparatus. There was, however, a 0.08 per cent. decrease in weight, so that it is unreasonable to attribute the growth to oxidation. On the other hand, if a greater circulation of air occurred in Rocquet and Olette's apparatus, it is possible that the small growth in their tests could be due to the inhibiting effect of a small amount of oxidation by the mechanism already demonstrated. It is possible, too, that the difference in growth could be due to differences in the rate of heating and cooling during each cycle. These results show how difficult it is to compare results from two different sets of apparatus.

Comments on Repeated-heating Tests in Vacuum

The most important observations from these repeated-heating tests in vacuum are:—



AP20 11 11C

FIG. 20.—*Growth Specimens after* 170 *heatings* 400-850-400 *deg. C. in Vacuum.*

(1) Growth can occur due to causes other than graphitization and oxidation.

(2) No stage was reached at which growth ceased.

(3) The presence of gases dissolved in the iron or in the surrounding medium is unnecessary to promote growth, as the material with the highest growth was melted and allowed to solidify in vacuum.

(4) By previously annealing in air, and permitting oxides to form in the iron, growth is inhibited, but not indefinitely. It appears that oxygen is driven off by repeated heating and the iron then behaves as if it has not been oxidized.

The results, therefore, lend strong support to the theory that cracks or bursting are caused by local differential expansions and contractions resulting from the $\alpha \rightleftharpoons \gamma$ structural changes. The severity of the differential expansions and contractions and their influence on growth would depend upon the composition and the structure of the material, its strength, particularly the weakening effect of the graphite flakes, the size of test-piece and the rate of heating and cooling. The fact that so little growth is obtained with oxidized metal suggests that oxide penetration may substantially prevent the expansions and contractions and possibly the structural changes from taking place. The following tests were therefore carried out to study the effect of oxidation on the formation and deformation and decomposition of austenite.

Effect of Oxidation on the Formation and Decomposition of Austenite

An interesting observation of the manner in which oxidation can enhance graphitization of pearlite is illustrated in Fig. 21. This is a macrograph of a tensile bar of a pearlitic ingot-mould iron that has been repeatedly stressed at 400 deg. C. and then annealed for 48 hrs. at 700 deg. C. Oxidation products surrounded the flakes in the pearlitic and outer ferritic areas, but where the oxidation products were absent in the core, the matrix was ferritic.

As an example of the effect of oxidation,

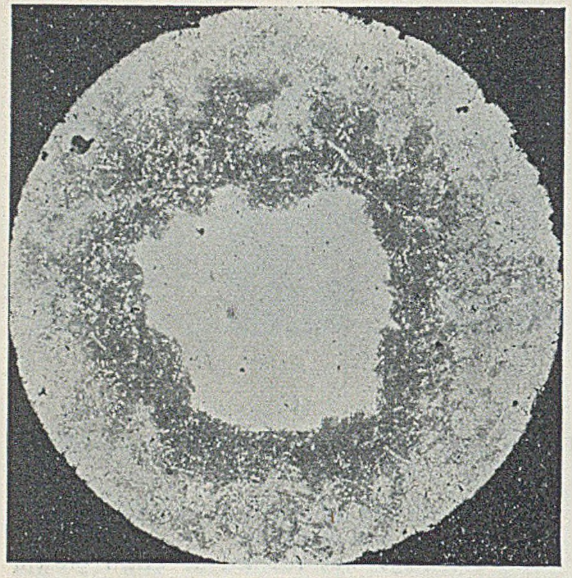


FIG. 21.—*Ingot-mould Iron Tensile Test-bar repeatedly Stressed at 400 deg. C. and then Annealed for 48 hrs. at 700 deg. C. in Air; showing Complete Decomposition of Pearlite to Ferrite in the Core, where it is not Oxidized.* ×2½ *approx.; etched in 4 per cent. Picral.*

samples of ingot-mould iron No. 3, which had been annealed in air for 400 hrs. at 700 deg. C. to make them entirely ferritic, were given the following heat-treatment:— (1) Heated to 850 deg. C. and air-cooled; (2) heated to 850 deg. C., held for 10 min. and air-cooled, and (3) heated to 850 deg. C., held for 30 min. and air-cooled. It was expected that the irons would be austenitized by this treatment and would cool as pearlitic irons. They were, however, essentially ferritic.

TABLE VI.—*Structures of Air- and Vacuum-annealed Iron No. 3 after Austenitizing Heat-treatments.*

Treatment: Time at temperature before air-cooling.	Proportion of Pearlite in Microstructure, per cent.	
	Air-annealed.	Vacuum-annealed.
800 deg. C. air-cooled after 10 min.	5	5 to 10
800 deg. C. air-cooled after ½ hr. ..	5 to 10	50
800 deg. C. air-cooled after 16 hr.	40	80
850 deg. C. furnace-cooled after 10 min.	40	90
850 deg. C. furnace-cooled after ½ hr.	30	95
850 deg. C. furnace-cooled after 16 hr.	30	90
930 deg. C. air-cooled after 10 min.	10	90
930 deg. C. air-cooled after ½ hr. ..	10 to 60	70 to 90
930 deg. C. air-cooled after 16 hr.	10 to 60	70 to 90

To investigate this behaviour further, a similar series of tests was carried out with No. 3 iron annealed in air, and with a similar block made ferritic by annealing for 400 hrs. at 700 deg. C. in vacuum. The treatments and microstructures are shown in Table VI; each specimen was approximately a ½-in. cube.

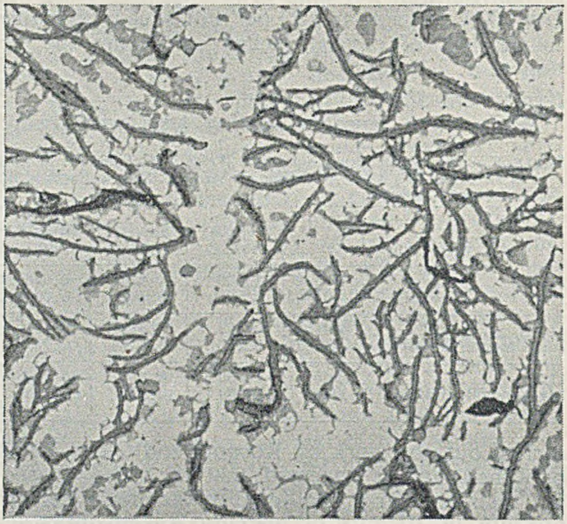


FIG. 22.—*Ingot-mould Iron No. 3 Annealed 400 hrs. at 700 deg. C. in Air, and then 16 hrs. at 930 deg. C. and Air-cooled;* ×60; *etched in 4 per cent. Picral.*

With the exception of the irons heat-treated for a short period at 800 deg. C., those previously annealed in vacuum and hence free from oxide penetration were substantially pearlitic, whereas those that had been air-annealed were mainly ferritic. Typical structures are shown in Figs. 22 and 23. The annealed block, from which these ½-in. cube specimens were taken, was 2 by 2 by 12 in. There was, therefore, an oxidation gradient across the section, and so the ½-in. heat-treatment specimens also varied in the degree to which they were oxidized. This accounts for the variation in amount of pearlite in some of the specimens, the most

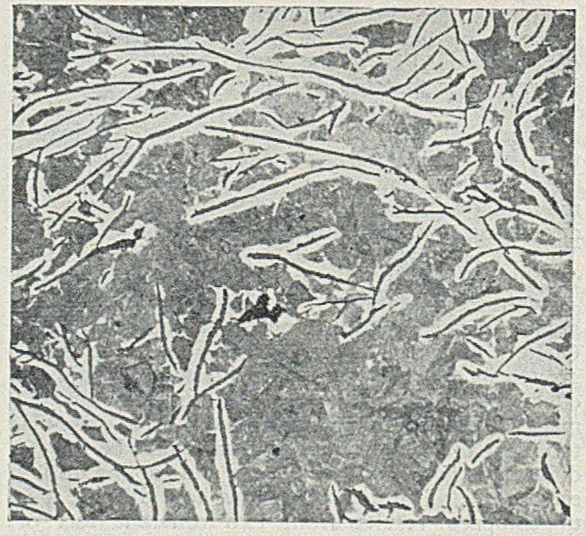


FIG. 23.—*Ingot-mould Iron No. 3, Annealed 400 hrs. at 700 deg. C. in Vacuum, and then 16 hrs. at 930 deg. C. and Air-cooled (compare with Fig. 22);* ×60; *etched in 4 per cent. Picral.*

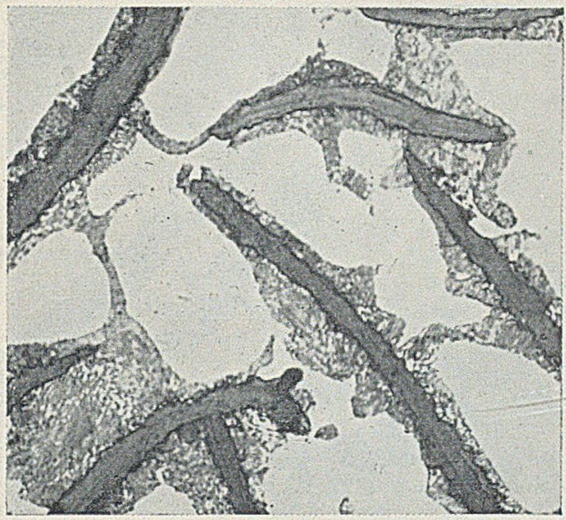


FIG. 24.—*Ingot-mould Iron No. 3; same as Fig. 22 but at* ×600; *etched in 4 per cent. Picral.*

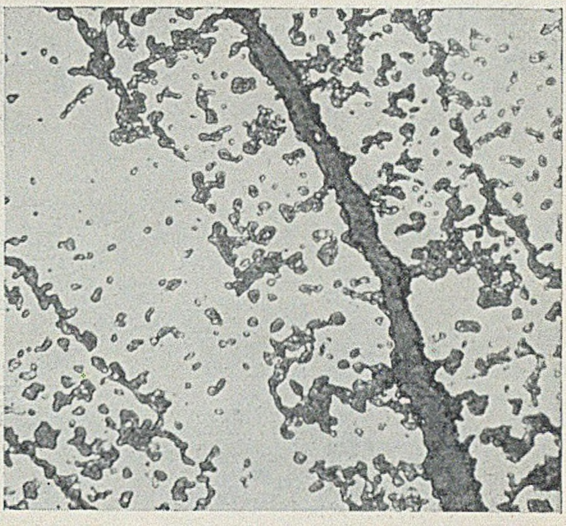


FIG. 26.—*Ingot-mould Iron,* 11X *at Centre; same as Fig.* 25 *but at* ×800; *etched in* 4 *per cent. Picral.*

pearlite being in the least-oxidized zones. In a case of extremely severe oxidation resulting from a 1,000-hr. anneal at 700 deg. C., a specimen was found to have only traces of pearlite after being held at 900 deg. C. for 16 hrs. and furnace-cooled. As was observed in some of the repeated heating tests (Fig. 12), the pearlite in the air-annealed samples was associated mainly with the graphite flakes (Figs. 22 and 24), whereas, in the vacuum-annealed samples, ferrite was associated with graphite (Fig. 23).

To see how a ferritic malleable iron responded to austenitizing, two pieces of blackheart malleable were raised to 900 deg. C. in 5 min., held for 10 and 40 min. and air-cooled. Both samples were

FIG. 25.—*Ingot-mould Iron* 11X *at Centre; after* 100 *heatings* 650-900-650 *deg. C. in Air;* ×150; *etched in* 4 *per cent. Picral.*

almost entirely pearlitic, showing that the graphite had readily dissolved in the austenite during this treatment.

It appears from these tests that, due to heat-treatment in air, the penetration of air into the iron prevents the solution of graphite in austenite on heating, and perhaps the precipitation of graphite from austenite on cooling. This effect is probably due to the isolation of the graphite flakes from the metallic matrix by the formation of an envelope of oxidized metal around the flakes. As the solution of graphite in austenite on heating is restricted, so also are the volume changes during the α to γ transformation. This difference between the behaviour of air- and vacuum-annealed cast irons is important, and may be largely responsible for the fact that much smaller growths are obtained in air-annealed than in vacuum-annealed cast irons during subsequent repeated heatings in vacuum.

Repeated Heating in Air

These tests were carried out to examine the oxidation products obtained by repeatedly heating an ingot-mould iron in the furnace atmosphere, and to compare the growths with specimens similarly treated in vacuum. Two specimens 2 in. long by 0.5 in. dia. of ingot-mould iron No. 11 were repeatedly heated between 650 and 900 deg. C. in an electrically-wound, horizontal tube furnace. The period of the complete cycle was about 2 hrs. Specimen 11X was packed with granular graphite in a graphite crucible to try to prevent excessive scaling; specimen 11Y was supported in a porcelain boat and exposed to the oxidizing furnace atmosphere. The growth results are given in Table VII. Scale had formed after 20 heatings, and was removed from the ends of the specimens before measuring, but after weighing. The growths and weights are therefore only approximate.

The figures indicate that the growths in air are

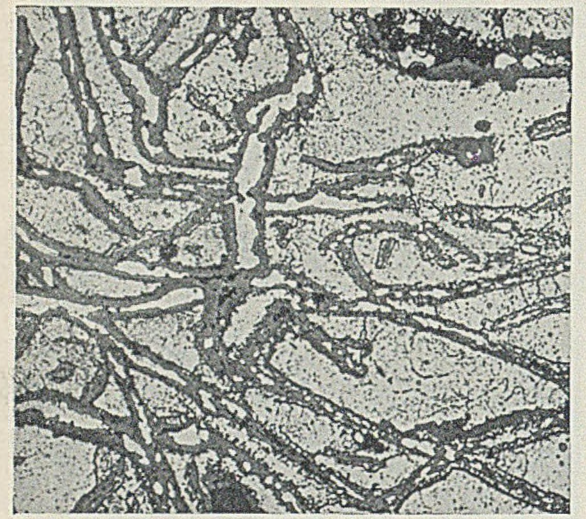


FIG. 27.—*Ingot-mould Iron,* 11X *at Extreme Edge, showing development of "White Flakes";* ×150; *etched in* 4 *per cent. Picral.*

in the same order as the growths in vacuum, *e.g.*, 8 to 10 per cent. volume growth after 20 heatings, compared with 10.1 per cent. in vacuum (Fig. 17), but the former specimens had badly oxidized and had different growth products. Micro-examination showed that both specimens were ferritic, and that severe oxidation had occurred from edge to centre. They displayed, however, a very interesting gradient of oxidation. At the centre, oxides were distributed throughout the matrix, but preferentially in the vicinity of the graphite flakes (Figs. 25 and 26). As the oxidation became more severe towards the edge, the oxides formed a continuous boundary, enclosing areas in the centre of which were the graphite

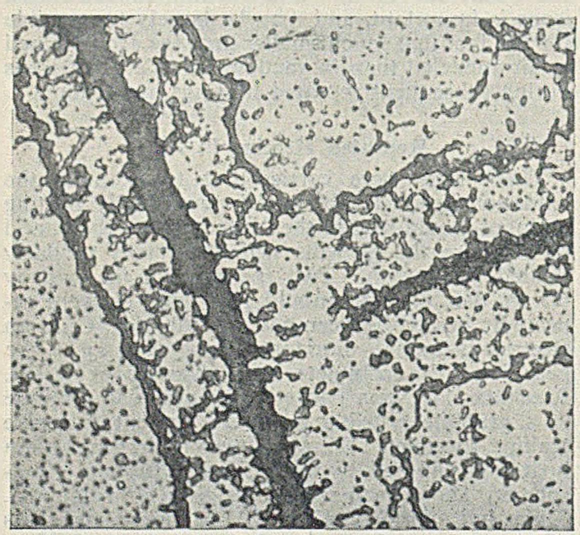


FIG. 28.—*Ingot-mould Iron,* 11X *near Extreme Edge; same as right-hand portion of Fig.* 27 *but at* ×800; *etched in* 4 *per cent. Picral.*

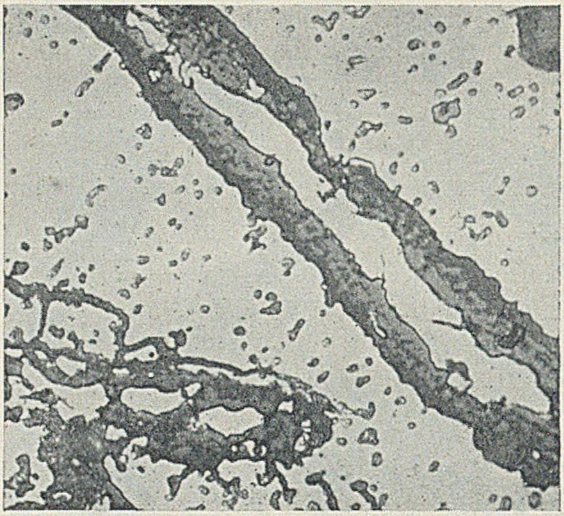


FIG. 29.—*Ingot-mould Iron,* 11X; *Extreme Edge showing development of "White Flakes"; same as Fig.* 27 *but at* ×800; *etched in* 4 *per cent. Picral.*

TABLE VII.—*Growths after* 100 *Heatings,* 650—900—650 *deg. C. in Air.*

Specimen.	Number of heatings in air, 650—900—650 deg. C.	Increase, per cent.	
		Volume.	Weight.*
11X, Ingot-mould Iron, enclosed in graphite	1	1.0	0.161
	2	1.4	0.235
	4	2.0	0.296
	20	8.0†	1.30
	100	19.4†	1.09
11Y, Ingot-mould Iron, exposed to furnace atmosphere	1	1.4	0.213
	2	2.0	0.352
	4	3.2	0.614
	20	10.4†	2.80
	100	31.4†	4.18

* Includes weight of scale.
† Dimensions with scale removed from ends of specimen.

flakes. Inside this boundary, the small oxide particles were concentrated, but outside the boundary they were sparsely distributed (Figs. 27 and 28). Further still towards the edge, the oxide boundaries had closed in towards the graphite flakes and also there was some removal of the graphite. At the extreme edge, where the oxidation was greatest, the oxide boundary had contracted further around the areas originally occupied by the graphite flakes, thereby enclosing the metallic matrix and giving the appearance of "white flakes," (Figs. 27 and 29).

These white flakes, like those formed by sub-critical temperature heat-treatment referred to earlier, (Fig. 9), were surrounded by a continuous oxide boundary and were noticeably free from oxidation products. The formation of the white flakes by this sequence of oxide diffusion offers a more rational explanation than Pearson's suggestion of re-precipitation of ferrite from the iron oxides. In general the microstructures were similar to those obtained near the working face of used ingot moulds. (See 7th and 8th Reports on Heterogeneity of Steel Ingots,[17, 18] Rocquet and Olette,[13], Lismer and Pickering[19]).

(*To be continued, see References on adjoining page.*)

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Nodular Iron with Calcium

Discussing the production of nodular iron with calcium in the "Quarterly of the Colorado School of Mines" (No. 1, 1953), Luiz Antonio de Araujo states that so far there are at least nine ways of producing graphite spherulites: (1) In hypoeutectic or hypereutectic irons by treatment of the melt with magnesium; (2) in hypereutectic irons by treatment of the melt with cerium; (3) in the solid phase by annealing whiteheart malleable castings high in sulphur and low in manganese; (4) in cobalt/carbon and nickel/carbon alloys, by treatment of the melt with calcium, cerium, bismuth, magnesium, zinc or cadmium; (5) in very-low-sulphur cast irons, simply by rapid cooling of the molten metal; (6) in tellurium-treated irons, forming spherulites just below the chilled zone; (7) using bismuth as a nodulizing element in grey irons having a low sulphur content; (8) production of nodular graphite irons by treating molten metal with titanium carbide, boron carbide and calcium carbide; and (9) by inoculation of the melt with calcium, either in the elementary form or combined with silicon. This last method is the subject of the present work, and the author's conclusions are as follow:—

In an attempt to find a safer and more economical substitute for the alloy treatment in current use in the production of nodular cast iron, several calcium alloys were used, alone or in combination, with the metal itself being used to inoculate cast iron. It was found that with the alloys used, the quantity required in order to obtain nodulization was far greater than the amount which the metal was capable of dissolving. In the later experiments, the addition of calcium had a marked effect on the physical properties of the iron, although a completely nodular structure was not obtained. When a suitable means of maintaining the temperature or of even superheating the iron was provided, nodulization took place, although only partially, due to the small amount (0.65 per cent.) of calcium added. At the present stage in normal foundry practice, the author concludes, the use of calcium in metallic form cannot compete successfully with the magnesium process, although the addition of calcium can be made more safely, and without danger of injury to the workers or to the equipment.

Ingot-mould "Life" Factors*

Ingot-mould consumption per ton of steel teemed varies between 10 lb. and 70 lb. in different works. Even within a single plant, the behaviour of different moulds may vary widely without any obvious cause. At 2d. per lb., every 10 lb. of mould metal per ton of steel costs £1,600 per week on a throughput of 20,000 tons of steel. The results of many years' practical research work on mould economy are being published as the Third Report of the Ingot Moulds Sub-committee.

Recording and supervising ingot mould use efficiently provides information which, if applied, can have a very great effect. One shop, for example, over a 20-year period cut consumption of one design of mould from 28 lb. per ton to 14 lb. per ton, and of another from 36 lb. per ton to 25 lb. per ton by this means. Similarly, another firm's new shop began with a consumption of 58 lb. per ton which was cut to 34 lb. in the course of 18 months.

Factors to be Considered

Teeming temperatures and the rate of heat dissipation, times from teeming to stripping, and intervals between use are among service conditions that affect mould "life". Evidence suggests that floor or car casting gives an average of 20 per cent. increase in mould life over pit casting, because heat dissipation is speeded. Increased spacing between moulds on bogies has resulted in increased mould life at several works.

Generally, the more quickly the moulds are stripped, the better they last. At one works, for example, standard semi-closed-top moulds had an average life of 158 casts in 1948. This declined over 17 months to 118. Longer stripping times were found to be the chief cause, and mould life quickly recovered to its former level when this was corrected.

Another factor influencing mould life is the interval between use. The best results are obtained when the mould is given long enough to cool to between 50 deg. C. and 100 deg. C. The effect of using moulds above the range was generally much worse than using them cold or nearly cold. When too few moulds are in service, therefore, mould life is likely to decrease.

Chemical composition can have a considerable effect on mould performance in certain circumstances. Though the masking effects of simultaneous variations in conditions of use and of amounts of the several elements present often make it difficult to observe their influence individually, some trends can be distinguished. For example, a statistical examination of 523 3¾ to 4-ton moulds at one works showed that an increase of phosphorus by 0·10 per cent. within the range 0·06 to 0·23 per cent. increased the average mould life by about 7 per cent. (nine casts). However, for moulds of 10 tons capacity or more, the evidence indicates that phosphorus content should not be more than about 0·06 per cent. It has now been possible to formulate recommended compositions.

At one works where 268, 22½-sq. in. moulds were examined for wall and corner thickness, only 38 per cent. were found to have all four mould walls of the correct dimensions and only 19 per cent. had all four corners the correct size. Those that had all walls and corners within ⅛ in. of the size specified had an average life of 145 casts. Those that had at least one wall

(*Continued at foot of Col. 1.*)

and one corner ⅛ in. or more below drawing size had an average life of 133 casts. In another case of moulds with a 4½-in. wall, some corner-thickness variations were made deliberately. These, along with moulds having accidental variations between corners, gave moulds with the thinnest corner varying from 3½ to 4½ in. Those with corners of 3½ in. had lives of 75 casts, and those with corners of 4½ in. had lives of 125.

The influences on mould consumption of service conditions, of the composition and properties of the mould metal, and of mould design are all important. Systematic attention in the light of the years of research work that has been devoted to the subject can often result in substantial savings.

* Extracted from a survey prepared by the British Iron & Steel Research Association.

Dietert Process for Precision Moulds*

By Harry W. Dietert

Since the Dietert or D-process for making precision moulds was first mentioned during public discussion of papers at the recent A.F.S. Convention, *American Foundryman* has been asked repeatedly for details. The inventor, Harry W. Dietert, president, Harry W. Dietert Company, has provided them. Special binder for the D-process was developed by Archer-Daniels-Midland Company; foundry adaptability of the method has been demonstrated by Wm. G. Ferrell, Auto Specialties Manufacturing Company.

The Dietert or D-process consists of blowing a contoured core around a pattern to form one-half of a mould. It may be likened to a modified shell mould where thickness of the contoured core is controllable over a wide range to make it suitable for a wide range of metals and casting sizes.

The moulding equipment required by this process consists of conventional equipment normally used in the foundry. The equipment required is a core-sand mixer, a core-blower, a pattern mounted on a blow plate, contoured carried plates, core oven and one special piece of equipment to clamp and hold the two half-moulds together during pouring.

The moulding materials required are: (1) silica or bank sand of A.F.S. fineness 90 to 150, and A.F.S. clay substance not exceeding 0.3 per cent.; and (2) a special oil binder that cures fast, is very strong, imparts good green-strength after ramming, does not require any water, has good bench life, has high "blowability," and will not stick to cold pattern or hot contoured dryer.

The pattern equipment which has proved suitable for this new mould making method is illustrated in Fig. 1. Since the mould is usually made with a core-blower, the metal pattern is mounted on the blow plate complete with sprue, runner, ingate and header. The blow holes are spaced around the perimeter of the pattern approximately six inches apart. The ½-in. diameter vent holes with fine mesh screen are placed around the perimeter of the contoured shell ½ in. apart. Thus the core is vented around its outer edge and core sand enters around the outer edge of the pattern.

Metal carrier plates are cast and so constructed as to wrap around the pattern, leaving a small space between pattern and dryer for core sand of the desired thickness. For the smaller-size moulds, a 3/16 in. thick core is satisfactory. A thickness of ¼ in. is used for medium-sized moulds and 5/16 in. thick cores may be used for the larger moulds.

The contoured cored mould can be made with a heavier cross-section at selected locations of the mould to withstand a heavy metal section. The contoured core may also be reinforced by ribs of sand. Only one pattern is required and it is machined to the desired accuracy, measurements being made at room temperature since the pattern is operated at room temperature. It may be bolted to the blow plate of the core-blower, or it may be placed on the base of the core-blower and the core blown through the carrier.

The contoured carriers can be of cast aluminium, grey iron or other materials. The inside of the contour carriers does not require any machining, thus they may be cast in green-sand and touched up with a file. The face of the carrier mating with the blow plate is machined or disc ground. When a rubber seal is used, this mating surface need not be in a perfect plane; a tolerance of ± 1/32 in. is allowable. The carriers should be ribbed for strength and the bottom of the carrier finished by machining or grinding.

The dried core-sand is usually mixed with 1 to 2¼ per cent. of Dietert Process binder for 15 min. Iron oxide or other extenders for core collapsibility can be used. The mixed sand flows like dry-sand but it is dustless. It possesses a sufficient green-strength in the sand chamber of the core-blower so that it will not flow out of blow holes without air pressure.

Returned, hot, contoured carriers are placed on the bottom stripping plate of the core-blower. Stop pins on the baseplate of core-blower locate the carrier so that pattern pins enter holes in the contoured carrier. The mixed sand blows easily into the restricted space, forming a densely rammed core on all pattern surfaces. The draft on the pattern can be as little as one-half degree. The stripping is clean and smooth without any sticking. The pattern is cleaned with alcohol or petrol before starting and when the day's work is completed.

Baking Cycle

The contoured carrier with the blown core is placed in a conventional core oven with temperature ranging from 260 to 370 deg. C. Baking cycle depends upon efficiency of oven, temperature, and size of core. Small cores have been baked completely in 12 min. under best of conditions. Plant practice to date on medium-size cores requires 30 min. for baking.

The hot core is removed by rapping the carrier and then lifting the core out of the carrier by hand. The hot carrier is then returned to the core-blower. The hot core is completely cured and does not warp out of shape. Strength ranges from 500 to 600 lb. per sq. in.

Both the mould side and outer surface of the core are smooth. The smooth outer surface allows for mechanical clamping and holding during pouring and metal cooling. The core mould requires no wash for grey iron or steel.

Both casting finish and the accuracy obtained with the D-process are comparable with those of the C-process. This process may find its greatest field in the production of medium to heavy iron and steel castings.

The cost of the binder, per 100 lb of core sand, is 50 cents (3s. 6d.). This, to date, does not indicate that it will prove to be more economical than green-sand moulding. It does, however, offer a possibility of improving the finish and accuracy of a new group of castings—as an example, making parts by casting which are now made by other methods. Indications are that the foundry, by using the Dietert process, has the opportunity of capturing a new, large tonnage of parts now made by drop forging.

* Extracted from the *American Foundryman* and slightly abridged.

THE "NICKEL BULLETIN," Vol. 26, No. 7, issued by the Mond Nickel Company, Limited, Sunderland House, Curzon Street, London, W.1, has more references to foundry practice than has been the case in recent times. Cast iron, alone, has seven abstracts, whilst in addition there is one on the machinability of cast steel, and another on magnets. This issue marks the completion of 25 yrs.' continuous publication and a special article is devoted to this event

Ceramic Moulds for the Foundry

By Thomas A. Dickinson

The possibilities of permanent or semi-permanent moulds have always held out obvious advantages to foundrymen, but their practical realization has often fallen short of desirable characteristics. In this article, a number of quite unorthodox methods of mould making in America are reported, some showing considerable promise.

Ceramics can be briefly described as essentially natural materials of the earth which may be modelled, moulded, trowelled, cast, or otherwise fabricated into useful articles. They normally comprise different quantities of metallic oxides, but are chemically classed as "non-metals." Among the ceramic products that are well known to foundrymen are refractory furnace components and crucibles for melting alloys of all types, sand moulds and plaster compounds for investment moulds and patterns. These particular products merit no more than passing mention in this article, since they have provided subject-matter for many previously-published words. However, it is believed that their proved usefulness has at least established the potentialities of ceramic moulding materials in terms of the following properties:—

(1) High heat resistance combined with low thermal conductivity.

(2) Relatively-high chemical inertness at temperatures required to melt a majority of commercial alloys.

(3) Very good fabricational qualities which permit the manufacture of accurate moulds with comparatively few defects and related difficulties.

Types of Ceramic Moulds

Generally speaking, these desirable properties have thus far been regarded as practical in the fabrication of temporary moulds, each of which could produce no more than a single casting. However, a number of foundrymen are known to have made use of permanent ceramic moulds and there is every reason to predict that many similar applications will be developed as the facts about modern ceramic materials become generally known. The principal types of ceramic materials can be identified with properties given in Table I and defined as:—

(1) *Glass*—comprising fused sand, quartz, and metallic-oxide compositions.

(2) *Porcelain enamels*—comprising mixtures of glass and clay compounds, which can be fused on metal surfaces to prevent corrosion and other undesirable chemical reactions.

(3) *Clay products*—comprising heat-fused clay or clay compounds such as pottery and structural brick.

(4) *Refractories*—comprising mixtures of clays, gypsum cements, etc., which have probably the highest melting points of any group of materials now known to exist.

Glass Materials

Of the types listed in Table I, glass materials appear to have the fewest probable applications in the fabrication of permanent moulds for casting metals—despite the proved usefulness of temporary sand moulds—since they normally melt at temperatures of less than 816 deg. C., and have relatively low resistance to thermal shock. However, research workers at California Institute of Technology have reported some success in the use of quartz-glass moulds for the precision casting of zinc, aluminium, and other alloys in the intermediate temperature range.

For the latter experiments, moulds were of the open type and the alloys were melted in the mould cavities to minimize the danger of damage due to thermal stresses. Vitreosil was the quartz-glass composition used in making the moulds, and it was cast in the molten state over preheated refractory patterns. The moulds had a coefficient of thermal expansion of only 5.0×10^{-7}, and each was capable of production from 10 to 25 identical castings without appreciable deterioration. The castings had exceedingly smooth and homogenous surfaces, but were necessarily rather small and simple in design.

TABLE I.—*Compositions and Properties of Typical Ceramic Moulding Materials.*

Type.	Typical ingredients.	Melting pt., deg. C.	Chemical resistance.	Specific gravity.	Tensile strength, tons per sq. in.	Linear expansion coeff.*
Glass	Silicon, carbon, iron and other metallic oxides.	550 to approx. 1,350	Sol. in hydrofluoric acid only	2.2 to 2.6	2.7 to 3.1	1.8 to 5.4
Porcelain enamel	Silicon, sulphur, zirconia and other metallic oxides.	820 to approx. 1,650	Similar to glass	2.5 to 3.0	0.7 to 4.5	8.0 to 12.0
Pottery clay ..	Silica, calcium, aluminium, sodium and other metallic oxides.	980 to approx. 2,000	Similar to glass	1.8 to 4.0	0.9 to 4.0	3.5 to 5.0
High-heat refractory	Silica and Aluminium oxide.	1,650 to approx. 2,750	May have little resistance to acids or alkalies.	3.0 to 4.5	0.5 to 1.6	1.0 to 6.0

* Computed as $\times 10^{-6}$ per deg. F. (0 to 90 deg. F.).

Ceramic Moulds for the Foundry

Vitreous-enamelled Steel

At Lockheed and other Western U.S.A. aircraft factories, porcelain-enamelled steel moulds have been used with some success for the casting of moderately-large and symmetrical shapes with alloys in the low and intermediate temperature ranges. Sheet steel is first press-formed to produce a metal cavity, by applying hydraulic pressure to a rubber "blanket" so that the rubber will sandwich the steel over a form block or pattern (made from cast plastics, low melting-point alloys, etc.). Then the cavity in the steel sheet is cleaned or degreased, etched with an acid pickling bath, and coated with porcelain enamel as follows:—

(1) A ground- or base-coat (comprising porcelain enamel frit mixed with adherence oxides and water) is sprayed on to the steel, dehydrated at temperatures of about 95 deg. C., and fused into the steel surfaces at a temperature of about 1,370 deg. C.

(2) A cover-coat (comprising about 95 per cent. zirconia, mixed with clay and water) is sprayed over the ground-coat, dehydrated as noted above, and fused at temperatures of 1,370 deg. C. or more into the ground-coat.

(3) A sealing coat (which is essentially the same as the ground-coat) is thinly applied over the cover-coat, then dehydrated and heat-fused as described for the initial coating.

Sheet-steel cavities, thus enamelled, may or may not be stiffened with a cast-alloy backing medium before they are coated. They can resist temperatures up to about 816 deg. C., if necessary, to produce an indefinite number of castings without acquiring cracks or distortion. Steel stock for pressing the cavities usually comprises 16 to 20 gauge material, such as Carnegie-Illinois "Vitrenamel," and the enamelling compositions were initially developed by the National Bureau of Standards, Washington, D.C., for use in improving the heat resistance of jet-propulsion airplane parts.*

It has been suggested that porcelain-enamelled sheet steel cavities, reinforced with cast-alloy backing materials, would be suitable as "long life" moulds for die casting; but, while a number of die casters are reported to be endeavouring to make use of such moulds at the time of writing, it seems evident that such work has not yet progressed beyond the "trade-secrets" stage.

Clay Products

To date, few, if any, Western U.S.A. foundries acquired the firing kilns and other facilities required to heat-fuse clay and related types of ceramic materials into permanent casting moulds. However, a number of companies have found it possible to have such moulds made to order by specialized ceramic manufacturers at apparently-reasonable prices. Among the latter firms, Pacific Clay Products and Pacific Tile & Porcelain Company have acknowledged successful efforts to make ceramic moulds in accordance with the following procedure:

(1) Patterns are made or modelled from a porous plaster compound such as "Hydrocal" in accordance with standard patternmaking procedures.

(2) If the pattern has undercuts or contours which require the fabrication of moulds in two or more pieces, a separate pattern may be used for each mould piece, or areas of a single pattern may be progressively masked so that pieces can be cast thereon in appropriately-dimensioned wooden boxes. Otherwise, open-type moulds are cast in boxes placed on a pattern using heat-resistant clay "slip" (*i.e.*, a clay and water casting mixture).

(3) Clay-slip casts are dehydrated to form cavity shells, clinging to the plaster cavities. Dehydration in this case is accomplished in open air at room temperature by the withdrawal of water from the clay slip through the pores of the plaster patterns.

(4) The cavity shells are reinforced with a coarse refractory backing material such as the "Super Castable" compound produced by LaClede-Christy Clay Products Company, St. Louis. Backing materials of this type are mixed with water, then cast and allowed to "set" like concrete at room temperature, after which they will develop ceramic bonds at elevated temperatures.

(5) Reinforced cavity units are fired at temperatures of about 800 to 1,050 deg. C. to fuse the ceramic constituents.

(6) The cavity surfaces are glazed for smoothness by applying, drying, and firing ceramic coating materials—in much the same way as metal surfaces are porcelain enamelled. A single glaze coating will reduce surface porosity sufficiently for most casting purposes, but two glaze coatings are applied when a high-gloss finish is desired.

Permanent moulds made according to the procedure detailed may have most of the design features of sand moulds, if necessary, and can withstand the temperatures required to cast many types of iron and steel as well as alloys in the lower-temperature ranges.

Refractory Materials

Refractory materials of the types used in investment casting are not normally adaptable for use in casting permanent moulds, since their composition is such that they are readily damaged. However, there are a number of castable refractories which do not suffer from this disadvantage. For example, in the Stainless Steel Products plant at Burbank, Calif., "Gold Bond" plaster compositions (made by National Gypsum Company) have been used to make open-type permanent moulds for casting alloys at temperatures of 250 to 550 deg. C. The mould materials in this case are mechanically mixed with warm water to a creamy consistency, and have been satisfactorily cast on "Hydrocal" patterns when the latter were carefully coated with a brand of liquid soap. Resultant defects due to air bubbles were either minimized or eliminated by means of a vibration process—whereby the mould is positioned on or attached to a machine-vibrated surface so that air

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* For further details, see Technical Note, 1626, available from the National Advisory Committee for Aeronautics, 1724 F Street, Washington 25, D.C.

TABLE II.—*Uses and Potential Uses for Ceramic Moulds.*

Ceramic type.	Mould type(s).	Alloys which can be cast.	Limitations.
Glass	Open, permanent for very small articles.	Lead, aluminium, magnesium, zinc, etc.	High costs, danger of thermal shock damage or breakage.
Porcelain enamel	Used to increase heat-resistance of permanent steel moulds.	Lead, aluminium, magnesium, zinc, copper, and some grades of iron or steel.	Special finishing and firing equipment is required; enamel can be readily chipped, sometimes by careless handling.
Pottery clay	Permanent moulds similar to most types of sand moulds.	Same as in porcelain-enamelled moulds.	Thick mould walls may be required to minimize effects of thermal shock; special ceramic production equipment is required.
Plaster-type refractories ..	Temporary and permanent moulds of all types.	Virtually all types.	Moulds will normally have low mechanical strength properties.
Fireclay or firebrick refractories.	Permanent moulds similar to most types of sand moulds.	Virtually all types.	Moulds are relatively expensive to fabricate, and can be damaged by carelessness in many circumstances.

bubbles will be dissipated as the material solidifies.

Setting of the " Gold Bond " plaster usually takes place in about 30 min., after which the patterns are removed from the mould cavities so that the latter can be dehydrated by heating to temperatures of about 200 or 250 deg. C. Silicone varnishes are sometimes used after the dehydration process to seal and increase the strength of cavity surfaces.

Castable refractories of the types used to line ultra-high temperature furnaces are often coarse in texture and exceedingly brittle; but, if handled with sufficient care, moulds made with such refractories might each be used to produce several iron or steel castings which are comparable to sand castings. Whether moulds of this type are being used in casting metal products cannot be authoritatively stated at present. However, it is a quite well-known fact that such methods have been used in the production of glassware for many years, and the conditions involved in casting glassware are very similar to the circumstances encountered in casting metals at temperatures of 800 deg. C. or less.

Potential uses for the various ceramic moulds described in this article are listed in Table II.

Publications Received

Quarterly Bulletin of Steel Statistics for Europe, No. 11. Published by the Industry Division, Economic Commission for Europe of the United Nations, Geneva, Switzerland. Obtainable from H.M. Stationery Office, P.O. Box 569, London, S.E.1. Price 7s. 6d.

This country is excellently served by the statistical department of the British Iron and Steel Federation for all figures associated with iron and steel production. The issue quarterly of similar matter in a bilingual book, French and English, using the metric system of weights, does not seem to add much to the total sum of useful knowledge of the industry from the domestic point of view and seems to be largely a work of supererogation.

Aluminium and its Alloys in Building. Published by the Aluminium Development Association, 33, Grosvenor Street, London, W.1. Price 3s. 6d.

The A.D.A. is to be congratulated on the production of this 76-page brochure, for not only is it magnificently illustrated but also well written. Its scope is quite comprehensive as it covers the use of aluminium —mainly in the wrought state—in the construction of industrial buildings; universities, schools, dwelling houses, shops, street furniture, churches and shipping interiors. Examples of castings, though few, are impressive and include " Eros " and the massive doors of the Ministry of Works. This is unquestionably a delightful brochure upon which to browse, and no doubt one of outstanding use to architects and the like.

" Metco " Metallizing Handbook. By H. S. Ingham and A. P. Shepherd. Published in Great Britain by the Metallizing Equipment Company, Limited, Woking, Surrey.

It is 43 years since Schoop invented the metallizing process, but it took a long time before it settled down into an economical commercial process. This 250-page, well-illustrated book of American origin gives ample proof of the place the process now holds in engineering. It clearly defines the sort of jobs where the process is applicable and outlines the techniques to be used when actually carrying out the work. The book is divided into eight sections and covers such diverse subjects as corrosion-resistant coatings; ventilation and safety measures. The book is essentially practical. As no price is mentioned it can be assumed that it is available for users of the process.

Japan. An Overseas Economic Survey. Published by Her Majesty's Stationery Office, York House, Kingsway, London, W.C.2. Price 4s. 6d. net.

This publication reaches the high standard attained in pre-war days, but not in recent times. Mere figures are insufficient. In this publication there is usually an authoritative reason for changes noted. Moreover, a really interesting account is given of the natural resources, industrial shortages and mentality of the Japanese. Little is said of the foundry industry, beyond tabular matter, wherein it is stated that the average monthly production of foundry pig-iron rose from 33,700 metric tons in 1949 to 49,600 tons in 1951, from which the output of iron castings can be roughly estimated. Average monthly liquid steel production for castings also increased from 14,800 in 1949 to 18,800 metric tons in 1951. From these quantities 9,300 and 12,300 tons of castings were made, apparently a fairly high yield. The average monthly production figures for cast-iron pipe similarly rose during this period from 5,000 to 8,700 metric tons, whilst enamelware likewise increased from 1,500 to 2,400 tons. The most important factor in future competition from Japan is the marked shortage of native ores and high transport costs to the consuming market, plus a promise to respect trade marks, Patents and designs.

Deoxidation of Iron by Titanium

Work Proceeding at N.P.L.

Over the past few years, the National Physical Laboratory has been conducting a series of experiments on deoxidation of iron on behalf of the British Iron and Steel Research Association, and recently trials have been carried out with titanium. Fifteen 400-gm. melts of electrolytic iron of very high purity, specially prepared by the laboratory, were used. Oxygen was added to these as ferric oxide. When the iron was about 50 deg. C. above its melting point, high-purity titanium was added in the form of sponge metal containing about 99.7 per cent. titanium. In four of the ingots, however, the titanium was not added until the temperature had been raised a further 150 to 200 deg. C., to break down bridges of solid iron which had formed after the melting of the lower part of the charge. The surfaces of the ingots were thoroughly filed to remove adhering refractory material or any other superficial oxide layer. The ingots were then quartered longitudinally and samples were taken for vacuum fusion analysis, for alcoholic iodine extraction, chemical analysis, and X-ray examination of the residues. Millings were chemically analysed for titanium.

Chemical and Physical Examination

The non-metallic residues were isolated by alcoholic iodine extraction at 65 per cent. C. and analysed gravimetrically. The oxygen contents were determined by colorimetric analysis. To estimate the free metallic titanium contents of the ingots, the titanium in the oxide residues was subtracted from the total concentrations of titanium. The only oxides other than those of iron and titanium found in the alcoholic iodine residues were alumina and silica, and these formed a very small proportion of the total oxide contents.

Segregation of inclusions was observed under the microscope. It was caused largely by the method of melting used. This method provides for the rapid cooling and solidifying of the metal after the titanium has been added. A high proportion of the products of deoxidation are thus kept in the body of the metal and this makes examination easier. Discrepancies in the results of the analyses were caused by this procedure, and also by the tendency of the deoxidation products to float upwards and become concentrated in the upper part of the ingots.

Debye-Sherrer powder photographs were taken of inclusions extracted by the alcoholic iodine method. The results showed that when titanium is in stoichiometric excess of oxygen, the principal product of deoxidation is α-Ti_2O_3. As the balance proceeds towards an excess of oxygen, the products are: α-Ti_2O_3, Ti_3O_5, TiO_2 (rutile), $FeO.TiO_2$ (ilmenite), a spinel and magnetite. In five of the ingots there were also large amounts of unidentified material, probably because of the presence of such impurities as silicon and aluminium oxides. There was nothing to suggest, however, that these miscellaneous constituents affect inclusions typical of the ternary system Fe-O-Ti.

Polished unetched sections from all ingots were examined under the microscope. The results showed that those inclusions which consisted almost entirely of α-Ti_2O_3 were globular or irregular in shape and their colours varied between a dark biege and chocolate; most of the irregular inclusions consisted of partly coalesced monocrystalline globules.

Process of Deoxidation

The deoxidation process may be briefly described as follows:—Reaction takes place in the molten iron between the dissolved titanium and oxygen until an equilibrium is reached between the residual titanium and oxygen and the product of deoxidation. After the iron has cooled and solidified, a further reaction occurs because of the shift in equilibrium. When there is sufficient titanium to leave an excess of 0.2 per cent. or more, the product formed is α-Ti_2O_3, but when a surplus of oxygen is left, the non-metallic inclusions consist, in the order of increasing oxygen content of the iron, of combined oxides of titanium, including ilmenite and a spinel. These compounds are generally found as mixtures, but they can be found alone.

Conclusions

The experiments show that deoxidation products in iron do not necessarily occur as compounds identical in appearance and colour with the pure counterparts. The products can only be identified positively by X-ray crystallographic methods, since a small departure from stoichiometric compositions can cause a radical change in colour. The alcoholic iodine method of extracting titanium oxide or mixed titanium-iron oxide presents no difficulty. Where metallic titanium is in excess, the oxygen associated with the titanium in the residues can be calculated on the basis of its occurrence as Ti_2O_3; where there is no excess, much of the oxygen may be combined with the titanium as TiO_2.

Rhodesian Metals Industry

According to the annual report of the Rhodesian Iron and Steel Commission for 1952, total production of pig-iron was 43,219 tons, of which 35,783 tons were used in steel production. This represented a daily output rate of about 118 tons a day, compared with 97 tons the previous year. Steel-ingot production was 38,636 tons, as against 29,260 tons in 1951. There was a drop in rolled sections at the Bulawayo works, due to a reduction in orders, to 3,063 tons from 3,602. At the Que Que works 20,054 tons were produced, compared with 16,129 tons the previous year.

Pursuing its policy of increasing production as a means of reducing costs, the commission has prepared a modified scheme, including the construction of a second blast furnace, designed to raise finished steel output to 65,000 tons a year.

In the first half of 1953, minerals produced in Northern Rhodesia were worth nearly £50,000,000. In June alone production was valued at more than £11,000,000, a record which was boosted by the output of 27,805 long tons of blister copper worth £7,281,988, followed by 12,193 tons of electrolytic copper (£3,264,556), and cobalt, zinc, and lead (£451,265). There were also small outputs of limestone, manganese ore, mica tin concentrates, and beryl.

Production of Diesel-engine Castings in Grey Iron*

Discussion of Mr. J. R. Charlton's Paper

Practical consideration of possible alternative methods of manufacture to those described by the Author for the type of castings mentioned provided the basis of this contribution to the Blackpool Conference of the Institute of British Foundrymen. The system of bedding down the pattern; checking and fixing the location of cores; mould drying in situ; *running and risering and the necessity or otherwise for camber all came in for expressions of forthright opinion. On balance, it was clear that casting design was usually the deciding factor in the choice of method. One speaker, himself a designer, condemned the castings described as out of date from an ease-of-manufacture viewpoint.*

Opening the discussion, Mr. Ed. Charlton congratulated his namesake on a very practical Paper, but said no data had been given as to the sand mixture used and asked whether any special moulding sand was selected for special jobs.

In Diesel-engine work it had been mentioned that the Author had bedded the patterns and did not turn them over. There seemed to be two accepted methods of this type of work; that of striking-off a bed, putting on the pattern and ramming underneath the pattern around the prints; taking off the pattern and setting the prints back into the imprints that had been made. Another method was to strike off a finished bed, to put the pattern on, get a good imprint, cut out the prints and set the prints back. Could Mr. Charlton say why he had chosen the particular method described?

Core Placing

The Author had mentioned that he had left a clearance in the window cores for the crankcase cores to go over, or down. It seemed to the speaker that there would be much flash produced by such a procedure where large cores were being handled. The clearance given to the cores had not been mentioned and he would like to know it. Did Mr. Charlton agree that it would have been better to take another method of relieving the box of the thrust of the window cores by putting the crank cores in and then sliding the window cores forward to prevent flash?

MR. CHARLTON said the moulding sand was the ordinary dry mix from the foundry. There was no addition of any kind to it. The reason why they carried out the level bed procedure was because this bed formed the core print and it was important in castings of that nature that the cores should rest on a level bed. Otherwise they would be shaken about like a ship in a storm, and as the metal thickness was only 16 mm. such disturbance could result in a core cutting through the wall of metal.

The core clearance could not be more than $\frac{3}{16}$ in. The alternative method mentioned had been considered and as could be seen from the side of the window cores there was a considerable danger that they might press against the crank square and dislodge some of the sand underneath. This could not be seen until the job was finished, but it would spoil the casting.

* Paper printed in the JOURNAL, July 30, 1953.

MR. LAWRIE said it was the type of paper that brought colour to the meeting for it touched on all types of foundrywork and gave everyone a chance to take part. He agreed with the methods described as he was at the moment making similar castings. One of the reasons why a bed was struck was that there was normally a camber required. He was pleased to see that the Author used check pieces on the cores because after all, no matter how carefully patterns or coreboxes might be made, there was always someone who could insert them the wrong way round. He had been very interested to see a fettler in a white overall. That was what they all sought, and he wished he could do it in his own foundry.

MR. CHARLTON pointed out that there was no camber whatsoever allowed on his jobs. As to check pieces, he felt that if there was a way for a moulder to go wrong one could be sure that someone would always find it.

MR. T. BURROWS agreed with the previous speakers. A point of interest was that the moulds referred to were made in moulding boxes—he presumed in complete boxes—and they were then dried *in situ*. Was there any special reason for that; was it because there was insufficient stove capacity? The drying occupied some 10 to 12 hrs. and he presumed the moulds were only dried to a certain depth.

Clearing up those points MR. CHARLTON said the moulds were made in composite boxes and in handling them for stoving purposes they would be distorted and there was also a real danger they would be distorted in the actual drying. The boxes were all built up and held by bolts and the way jobs were slung nowadays there was a liability of their being twisted and that would mean scrap castings.

For drying, the moulds were subjected to 10 or 12 hrs. treatment using forced draught, and the method was very successful. As Mr. Burrows surmised, the moulds were only dried to a certain depth; it was almost impossible to dry a mould right out without burning the face of it.

Mould Drying and Pouring

MR. H. HAYNES said the Author had shown how he removed the pattern when forming the prints and he did not condemn that method, but he had some suggestions which might help others. First, he would have the pattern so made that the moulder

Production of Diesel-engine Castings—Discussion

could walk along the bottom of the mould to finish the bed; and then make two half-cores suitable for dropping. For drying, he suggested a simple method occupying about 1½ hrs., then the moulds could be cored up the same day and cast. The moulds could be dried by the use of a simple gas jet 1-in. dia. with ⅛-in. holes running along it for eight inches at the end. That would dry the moulds in 1½ to 2 hrs. and then the moulder could set the cores up to get ready for pouring.

Mr. Haynes complained of the shortcomings of designers who would not listen to the expert advice of the foundryman and usually made the pattern so difficult that is was almost impossible to get good castings from it. He had noticed from the running of the casting that there were two spray runners along the top, running from the direct runners. He did not know what those two little runners were going to do there; he could not see them conveying the metal down to feed along to the other end. He could understand if there were two separate downgates and then the other stoppers could be lifted out and flood the metal along. Yet to lift them out and run them at the same time as the main downgates, he could not believe would be successful.

Going back to the Mirrlees cylinder block, he agreed it was a routine technique in altering that pattern for safety purposes to see that the cores were set in the right position to keep the correct thicknesses of metal. The Author said he had noted a certain amount of turbulence produced by the two streams of metal from each end meeting each other in the middle. They had been discussing making a small casting, but how would they proceed when they had to use two ladles, running from one end to another. With his own firm, they had cast (and very successfully) with two ladles, 10 or 12 tons each and run from both ends.

He could not understand why foundrymen still favoured square runners. He had not used a square runner for the last 20 years. When they tapped a furnace they used a round hole, why not a square one ? He did not believe in putting a wedge on runners for it resulted in an ugly lump on the casting.

From the illustrations it seemed that a large quantity of risers were used. He did not know why foundrymen relied on such a system. The making of risers took time and, moreover, introduced a quantity of dirt into the casting. He would prefer to have only four run-off risers in a 28-ft. casting, but what he did stress was the putting of pressure on such castings and provision had to be made for that.

Mr. Charlton agreed as to the drying of a mould, but one had to utilise the plant available. Until three months ago there was no gas in his foundry. As to running with two ladles, on a big job it was essential and there was no reason why there should be any trouble, but, as was explained, the operational reason why they ran on with ladle was due to the conditions for that particular job and in that particular foundry bay. Moreover, there was such a small casting space to operate two streams simultaneously. It was not as if there was a big expanse of mould where the metal could spread itself.

The pros and cons of round and square runners were being argued long before he had been born and he expected the argument would continue long after his death. In his part of the world square runners were used and so far he had not seen any trouble from them.

As regards the two relief runners on the top, they were put on jobs of that nature, but what happened inside the mould was purely guesswork. Relief runners were used because it was felt that they were effective, but whether this was really the case was a matter for the experts.

He was an advocate of a plethora of risers to help to evacuate gases. Founders could never be sure that the moulder had taken the necessary care with the vents.

Another Member confirmed this statement. He did not depend on risers, but thought they were a real help in evacuating some of the steam from the job and in his district founders believed in using as many risers as it was possible to get.

Mr. Haynes said he had just seen a casting 20 ft. long with 16 risers three inches in diameter. Yet he had made many dozens of such castings with complete success and never had risers on the flange of the square where it rose to the engine bed. He cast them with no risers at all on top, but with only four run-off risers. The casting was from 5 or 7 in. thick at the bottom to ⅞ in. thick elsewhere. There were no chills or denseners whatever; feeding was all done by pressure head.

Mr. Charlton commented that as long as they got satisfactory jobs in a jobbing foundry, he did not think it wise to change the methods too often.

In answer to a question on core tolerance and core-sand mixtures, Mr. Charlton said that the cores were made with a tolerance so as to avoid rubbing as far as possible. They shifted but little. Oil sand was used for the cores, whilst the natural bond of the sand gave good green-strength and there was no sticking in any of the cores.

Camber

A Member referring to camber, said he had brought up the subject before but he thought there was no agreement on the subject—there always seemed to be a conflict of opinion on the necessity for it. He personally allowed for camber, for where it was not allowed camber in the casting resulted. The Institute's president, Mr. Longden, had done much work on camber and had published data which were fairly easy to handle, but the system was not consistent. Could anyone tell him why?

Dr. A. B. Everest, from the Chair, said he thought they would have to rule out a discussion on camber as being out of order at that moment.

Mr. Charlton said, in the jobs described so far, there was no trace of camber of any kind. In other cases, he did allow for it. However, he had had the same experience as the speaker and was in the same position of feeling there was much to be discussed.

Mr. H. Haynes suggested that overcomincamber was a matter for experience; there was no set rule. Design made a great deal of difference to camber. In castings he had made there was no camber whatever put on a casting 28 ft. long. It seemed to be governed by depth. Foundrymen should consider the depth of a job and base their judgment on this. Camber or its omission was a matter of trial and error and, once the camber for a given casting was established, it must be adhered to subsequently.

Pertinent Points

MR. HUGHES commented on a few points Mr. Charlton had made in his paper, the importance of which had not been fully realized because of the concerned co-operation between the moulder, core-limited information he had given with it. The first maker and patternmaker, when coring up the mould. He was sure Mr. Charlton was convinced, as were many others, that such joint procedure did pay dividends in the production of castings of that nature. With regard to the core-sand mixture, in which there was about 40 per cent. naturally-bonded red sand, the Author had mentioned the need for good collapsibility in many of the cores to avoid cracking. He would have thought, however, that such a high proportion of red sand would have aggravated such a tendency, because of the high clay content. Increased quantities of binder were also necessary when a large proportion of fines were present.

Another point was the fact that Mr. Charlton allowed his cores to cool off in the stoves for four hours. That might have advantages, but it was wasteful in many ways. It was the custom for most founders to keep the heat in the stove and take advantage of it for the next batch of cores. Could Mr. Charlton say what was the purpose in allowing cores to cool in that fashion?

Dealing with these points, MR. CHARLTON explained that there was no question of cooling the cores; the time quoted was the stoving period allowed to obtain perfect baking right through the core and to avoid any further cracking.

MR. WEAVER asked if Mr. Charlton could tell them the dimensional accuracy to which the castings described were made. Was there any allowance for accumulated errors, or was it covered by an excessive machining allowance?

MR. CHARLTON said dimensional errors were taken care of in the machining allowance; it had been found that that was the safest way. For the engine frame, on the length there was about $\frac{3}{4}$-in. machining allowance.

MR. COLLINSON said he was one of those people whom one of the previous speakers did not like—a designer of castings. He imagined that the casting which they had been shown was designed purely to employ patternmakers—surely a patternmakers' paradise! He could see no point in making it in that manner at all. He asked whether the job was designed 30 yrs. ago for there seemed to have been no advance since those days.

Speaking to people who were very much more expert in such matters than he, he would have designed the job so that it could have been split the other way, vertically, to make two boxes. To mould it in that way would have cut out about half the cores and then he would have put the boxes together and poured through the joint.

MR. CHARLTON said he could not answer the question concerning design, but as regards moulding in halves he thought they would then have had to put in more time on the job in their particular foundry. Moulding in halves meant more man/hours, and in their particular part of the world man/hours were a very precious commodity.

Before passing on to the next Paper the CHAIRMAN thanked Mr. Charlton for a very interesting paper which had appealed to most practical foundrymen and provided an opportunity for them to express their views.

British Memorial Fund

The Honorable Sir John Lienhop, Agent-General for Victoria and chairman of the London selection committee, British Memorial Fund, is pleased to announce that, after having received many hundreds of applications and inquiries, all of which were given every consideration having regard to the requirements of the executive committee in Melbourne, the London selection committee have made recommendations as to three of the four fellowships to be awarded for 1953-54. The fourth, the fellowship in metallurgy, has not yet been awarded but it is hoped that interviews of suitable candidates will be held in the very near future. The Fellows, all of whom will receive an award of £1,000 (Australian), are to travel to Victoria during late January or early February in order to arrive in Melbourne in time for the commencement of the academic year which is in March. They will be met on arrival by a reception committee and members of the British Memorial Fund who will be responsible for arranging their accommodation and studies at the university.

Metallurgy Classes in London

The head of the Department of Applied Chemistry of the Northampton Polytechnic, St. John Street, London, E.C.1, Dr. J. E. Garside, has sent us that portion of the calendar covering the courses organized by this section of the college. It deals *inter alia* with a part-time seven-year course in metallurgy. Seven years seems a long time, but such a period of systematic study is bound to reap a rich harvest. During the autumn, there is to be a special series of 12 weekly evening lectures on Refractories, their Manufacture and Use, by Mr. L. R. Barrett, M.A., commencing on September 29.

There is to be a second series of eight lectures on Chemical and Metallurgical Thermodynamics by Dr. O. Kubaschewski, commencing on September 30. This seems to be of the type indicated by Dr. Ivanoff as being necessary to complete the training of the scientific assistants in the foundry industry.

AN OFFICIAL STATEMENT issued by Dorman, Long & Company, Limited, states that the company's Lackenby open-hearth steelworks is nearing completion and that the work of preparing the plant for operation is in an advanced stage.

Conference on Hardness Testing

A special conference of the Sheet and Strip Metal Users' Technical Association has been arranged to be held on October 14, 15 and 16 in the City Hall, Sheffield, which will be devoted to consideration of the numerous aspects of hardness testing. This will be of particular interest to sheet-metal users, but also of interest to all concerned with hardness testing.

The hardness testing conference sub-committee has considered the practical aspects of hardness testing that are now arising and have invited a number of well-known experts to contribute papers. The full programme has now been arranged and is as follows:—"Hardness Testing with the Vickers Machine" by H. G. Harper, of Vickers Armstrongs, Limited; "Rockwell Hardness Testing of Sheet Material" by V. E. Lysaght, of Wilson Mechanical Instrument Company; "Standard Indentation Tests" by Dr. K. Meyer, of the *Institut für Harterei Technik*, Bremen-Lesum; "Micro-hardness Testing" by E. B. Bergsman of AB Svenska Metallverken, Vasteras; "The Reichert Micro-hardness Tester in Practice" by Dr. Onitsch, of Shandon Scientific Company; "Reproducibility of Hardness Tests" by J. Woolman, of the Brown-Firth Research Laboratories; "Scratch Hardness Testing" by D. A. Oliver, B.S.A. Group Research Laboratory; "Practical Applications of the Double Cone Indentor" by P. Grodzinski, of Industrial Distributors (Sales) Limited; "Value of Hardness Testing as Inspection Procedure" by Dr. W. G. Shilling (A.I.D. Harefield), and "Physical Meaning of Indentation Hardness" by Dr. D. Tabor, of Cambridge University.

An exhibition of hardness testing machines and equipment will be staged by the manufacturers throughout the period. This exhibition will be opened by the Lord Mayor of Sheffield, Councillor Oliver S. Holmes, at 2.30 p.m. on October 14, in the Mezzanine Hall of the Sheffield City Hall. The incoming Master Cutler, Mr. R. L. Walsh, who takes office on September 7, will be opening the conference at 9.30 a.m. on October 15.

Completion of a New Factory

Geo. W. King Limited, manufacturers of mechanical handling equipment, have recently completed the last stage of a move which has brought the whole of their works and offices together on one site at Stevenage, where the administrative and drawing offices are now housed in a modern building designed and built by the firm's own building department.

Mr. G. King was born in the U.S.A., reached this country in 1891 *en route* to Australia, but fate decreed that he should stay in England. He worked for a while as a stevedore at Tilbury. This experience gave him more than a passing interest in lifting and shifting. Eventually he set up business at Stratford-by-Bow, making and selling hardware and agricultural equipment. Within a few years, the firm needed space to accommodate its steady growth. Its activities were therefore combined with those of a very old-established Hitchin firm called Innes & Company, makers of agricultural machinery and dairy-farm equipment. To-day the combined businesses have developed into a public company employing over a thousand people.

INCLUDED in the British Railways' Doncaster Plant Works' Centenary Exhibition on September 19 and 20 will be the latest electric locomotive for express passenger services between Sheffield and Manchester, and the electric locomotive in use on the Wath mineral section of the electric railway.

Taxation Matters

In the recent issue of a "General Bulletin" of the Council of Ironfoundry Associations, there appear notes on the present industrial taxation system which have been abstracted below:—

Apprentices: Tax-free Allowances.

The Chancellor of the Exchequer has agreed to double the tax relief of £26, which may be claimed by a parent in respect of a child undergoing training as an apprentice in industry. The parent of an apprentice to founding, therefore, may now claim relief from taxation of £52 on his behalf. The point may be of interest to foundries who are asked for information by parents of intending or serving apprentices.

Tax Allowances for Machinery.

The Inland Revenue has issued an up-to-date list of tax allowances which manufacturers may claim in respect of machinery and plant. The title of the publication is "Income Tax. Wear and Tear Allowances for Machinery or Plant. List of Percentage Rates." The cost is 9d., post free, and copies may be obtained from H.M. Stationery Office.

Death Duties.

The Chancellor of the Exchequer is himself conducting an investigation into some of the anomalies with which the operation and incidence of death duties are hedged. Some copies of a booklet entitled "Death Duties and the Manufacturing Business" are still available to member-firms of the C.F.A. on application to the secretary at the price of 2s. 6d.

Sir John Cass College

During the next session, the Sir John Cass College, which is situated in the City of London in Jewry Street, Aldgate, E.C.3, is organizing a series of lectures by a number of authorities on the "Scientific Principles of Fuel Technology." The lectures start on October 8 and continue virtually weekly until May 12. The fee for the course is £2 2s. 0d. In the new year, starting on January 4, there is to be a laboratory course on "Solid Fuel Analysis" conducted by Mr. S. Wald, B.Sc.; this, too, costs £2 2s. 0d.

The college has a Department of Metallurgy headed by Mr. L. Singlehurst-Ward, B.Sc., which is well known as one of London's centres for acquiring—by whole or part-time study—academic degrees in this branch of science.

Bilston Foundries' Report

At the thirteenth ordinary annual general meeting of Bilston Foundries, Limited, held on Monday, August 24, at Bilston, Mr. H. C. Sargent (chairman and joint managing director) disclosed net profit of £35,738, an increase of £4,412 over that for the year previous. It was proposed that a dividend of 20 per cent., less income tax, be paid on the ordinary shares—the rate forecast in the prospectus issued in November last. He said the demand for the company's products had been fully maintained during the year, there had been no falling off up to the present time, and providing stable conditions were maintained, the prospects for the coming year could be viewed with confidence. Concluding, he paid a warm tribute to the whole of the employees.

Personal

Mr. H. W. Dietert has accepted an invitation to deliver the 1954 Hoyt lecture before the American Foundrymen's Society. His subject will be announced later.

Mr. P. H. Nye, manager of the business development department of the General Electric Company, is retiring at the end of this month after completing 54 years' service with the company.

Mr. G. H. Toop has left his position as field development engineer with George Kent, Limited, meter manufacturers, etc., of Luton (Beds), to join George Kent (S.A.) (Pty.), Limited, Johannesburg, as development engineer specializing in automatic process control.

Mr. Matthew Johnson, a moulder, after 40 years' service with the Carville Engineering Company, of Wallsend-on-Tyne, has been presented with a gold watch in recognition of his service. The presentation was made by Mrs. B. Grant co-owner of the firm, which is 50 years old.

Mr. J. H. Tangye, eldest son of George Tangye, one of four brothers who founded the well-known Birmingham engineering firm bearing the family name, has just entered his 91st year. Mr. Tangye was a director of the firm from 1893 to 1930 and works manager from 1893 to 1910. He still visits the factory daily.

A dinner in honour of Mr. William Blackwell, who, until he became president of the Midland Area of the National Union of Manufacturers earlier this year, had held the office of chairman for 10 years, is to be given on September 23 in Birmingham. Mr. Blackwell will be presented with an illuminated address contained in a silver casket.

In his capacity as chairman of the Midland Regional Board for Industry, Major C. R. Dibben is to have, initially, the task of setting up local productivity committees under the auspices of the British Productivity Council. In the Midlands, it is planned to establish committees at Birmingham, Wolverhampton and district, Shrewsbury and district, Dudley and district, Kidderminster and district, Wednesbury and Darlaston and Stafford and district.

Mr. Alan Knight, a Rednal wrought-iron craftsman, is president of the Worcestershire Guild of Artist-Craftsmen, formed last year and which organized its first major exhibition at the Midland Institute, Birmingham, on August 31. The exhibition was opened by Dr. Mary Woodall, keeper of the Department of Art at Birmingham City Museum and Art Gallery. The Guild jealously guards its professional status by insisting that all its members depend on their work for their living. The Guild's aim is to show that handmade goods of fine quality and design can be obtained at prices which compare well with mass-produced articles.

To co-ordinate and develop all its commercial activities at home and overseas, D. Napier & Son, Limited, aeronautical and general engineers, of London, W.3, have appointed Mr. R. M. Hilary to be commercial manager. This is a new post in the organization of the company, which is a subsidiary of English Electric Company, Limited, and has been prompted by a phase of rapid expansion on which the firm has embarked. In 1930, at the start of his career, Mr. Hilary joined the Gas Light & Coke Company; five years later he went to Imperial Airways, which eventually became the British Overseas Airways Corporation.

New Catalogues

Worm-Spur Gear Unit. Higgs Motors Limited, Witton, Birmingham 8, have used a single page leaflet designed for incorporating in their loose-leaf catalogue to illustrate, describe and price a new machine—a low speed worm-spur gear unit. This has an output torque of 100 lb. ft. between 1.1 and 15 r.p.m. A feature of the unit is that the gears, carried between ball bearings, are completely enclosed and run in oil, whilst the motor shaft protrudes through the worm and is supported by a third bearing housed in the gearbox.

Hot-blast Cupolas. A brochure received from Cupodel, Limited, of 86, South Road, Northfield, Birmingham, 31, is of the type that will be filed for reference purposes, because it deals with a subject well to the forefront in foundry development. Yet its format is of the horizontal type instead of the more normal vertical presentation. It is, however, very nicely produced, and both the letterpress and the illustrations serve to present a very readable and interesting account of the potentialities of the hot-blast process. The brochure is available to our readers on writing to Northfield.

H.-F. Induction Heater—A brochure received from Airmec Limited, High Wycombe, Bucks, takes the form of extremely neatly produced mimeographed quarto sheets together with a photograph of a new 5 kw. electronic generator (type 850). It is of the sort which generates heat in the skin of the article to be treated. The equipment, it is stated, will heat up work at distances up to 12 ft. away from the generator. It appears to be interesting for the large quantity production organizations in our industry and that type of concern should write to High Wycombe for a copy of this brochure.

Domestic Space-heating Apparatus. Radiation Limited, Radiation House, Stratford Place, London, W.1, have issued four leaflets dealing with solid-fuel-burning apparatus. The production of such trade literature is extremely difficult, as it has to make an appeal to the architect, builders' merchant—both large and small firms—and the householder. It has to be reasonably artistic ; not too expensive, as large quantities have to be prepared ; the technology has to be simple and clearly set out. In all these essentials, three of these leaflets excell, whilst in the case of the fourth (S11/B/535) a better choice of type could possibly have been made, as a cramped appearance results.

Chills. The Fanner Manufacturing Company of Brookside Park, Cleveland 9, Ohio, have sent us a remarkably fine and interesting catalogue covering a wide variety of spiral, elongated nails, spiders, ram up, external radius, half-round chillers; ball-head foundry nails and core ties. The catalogue devotes two pages to what are termed super chills. These are of square section made from ¼ to ⅝ in. stock with a body length ranging from ½ to 6 in. The length of the stalk varies with the size. Core ties are used to prevent core shifts—a prolific cause of scrap in this country. Though the method is well illustrated and it is said they fit into the core point, perhaps the heat wave has made the reviewer somewhat "dumb", but he still cannot see how anchorage is effected. He however does appreciate the twisted jaggers as providing a better grip. We rank this catalogue very high and as there is an offer to send it along to our readers on demand, we suggest they should take advantage of by writing to this 60-year-old concern at Cleveland.

News in Brief

HIGGS MOTORS, LIMITED, of Witton, Birmingham 6, have just issued their September stock list.

G. & J. WEIR, LIMITED, Glasgow, announce that they are removing their London office on September 12 to Dunster House, 37, Mincing Lane, London, E.C.3.

MATLOCK LEAD MINES, LIMITED, have discovered a rich deposit of lead ore, under Starkholmes and Riber Hillside, Matlock, the result of more than two years' prospecting.

THE ROYAL PHOTOGRAPHIC SOCIETY is holding a Centenary Exhibition of Pictorial Photography from September 10 to October 17, in the Society's House at 16, Princes Gate, London, S.W.7. Admission is free.

SOME BELLS moulded in the 15th and 16th centuries are still in service, according to Mr. Paul Taylor, who is connected with the famous firm of bell-founders, Loughborough, when addressing the Ilkeston Rotary Club.

A PRESS CONFERENCE at which preliminary details will be given concerning a Scottish Industries Exhibition is being held at the North British Station Hotel, Princes Street, Edinburgh, to-day, Thursday, September 10, at 3 p.m.

THE TELEPHONE NUMBER of the Iron and Steel Board is now TRAfalgar 8833. Access to the Board's offices at Norfolk House is temporarily through the entrance at 30, Charles II Street (off Lower Regent Street). The postal address is Norfolk House, St. James's Square, London, S.W.1.

TWENTY-NINE PENSIONERS of the Smethwick foundry firm of Evered & Company, Limited, went back to the works on Thursday, September 3, for their annual reunion. They were entertained to tea by the managing director, Mr. Archibald Wilson, and afterwards went round the factory.

THE "BABY" OF THE BRITISH RAILWAYS standard types of locomotives has just been built at the Crewe works. It is the first of the Class 2, 2-6-2 mixed-traffic tank engines and weighs 63 tons 5 cwt. Twenty of this class are to be constructed. They will be used on the London Midland Region for branch-line work.

PERKINS PRESSURE CASTINGS COMPANY, LIMITED, was registered on August 25 as a private company with capital £2,000 in £1 shares. The registered office is 19, Selborne Street, Walsall, and directors are Mr. Ernest Perkins and Mr. Ernest G. Perkins, both of Walsall and directors of E. Perkins & Company, Limited. The secretary is E. Baker.

THE THIRD extension to the Heriot-Watt College, Edinburgh, construction of which has begun, will include a group of laboratories devoted to fuel technology. This is in keeping with the emphasis on east of Scotland industries, and marks the important part which fuel utilization plays and will increasingly play, in this part of Scotland. One of the large laboratories in the new seven-storey block will be devoted to metallurgy.

FOR THE SECOND YEAR running, the British Thomson-Houston tinsmiths' department was awarded the cup for the best entry in the annual apprentices' Rag Day procession, held in Rugby on August 29. The day started with a "dawn raid" on the town and ended at midnight with a ball, attended by 1,000 people. Proceeds of the Rag were in aid of the Warwickshire Red Cross Society scheme for sending tubercular children to Switzerland.

A NEW BRICK-MAKING MACHINE, which can set 2,500 bricks an hour ready for the firing oven, has been assembled in Bannockburn and despatched to an English brickworks. It is the first of its type and was made by the firm of James Mitchell, Rosebank Ironworks, Cambuslang, and assembled at their Bannockburn plant. It weighs 14 tons and has only two presses compared with 16 in most machines now in operation. The size of the brick is adjustable.

MECHANICAL STOKERS fitted to 18 furnaces have resulted in a saving in coal of up to 40 per cent. at the Brightside, Sheffield, works of William Jessop & Sons, Limited, and J. J. Saville & Company, Limited, both controlled by the Birmingham Small Arms Company, Limited. The works at present uses 750 tons of coal weekly, and the equivalent of 800 tons in the form of gas and electricity; eventually all furnaces will be mechanically stoked.

ALTHOUGH there was a substantial recession in orders during the past 12 months, the trend is now improving, says Mr. R. W. Fovargue, chairman of Smith & Wellstood, Limited, stove, range, and boiler makers, of Bonnybridge (Stirlingshire), in his statement with the accounts to June 30 last. Group trading profits fell from the previous record figure of £265,177 to £167,307 in the year under review, while net profits, after providing £64,382 (£118,577) for tax, declined from £97,298 to £53,276.

TOWNSEND & COMPANY, LIMITED, 214, Youville Square, Montreal, P.Q., Canada, wishes to contact U.K. manufacturers of rigging and straining screws, open-faced turnbuckles, anchor and chain shackles, and chain links. Interested manufacturers should communicate with the company at the above address, and are requested at the same time to notify the Board of Trade, Export Services Branch, Lacon House, Theobalds Road, London, W.C.1 (E.S.B./1834/53), of any action taken.

FOLLOWING a visit to the works of John Fowler & Company (Leeds), Limited, the Burmese Purchasing Commission has placed an £85,000 order for Fowler "Challenger 4" Diesel crawler tractors. The machines are to be supplied with earth-moving equipment and spare parts, and delivery is to be completed before December. The tractors will be distributed through the firm's associate company, Marshalls (India), Limited, and on completion of the contract, Fowler's chief field engineer will visit Burma to instruct local personnel in their operation and maintenance.

A NEW COMPANY being formed to continue the Birmingham silversmiths' and goldsmiths' business of Adie Bros., Limited, will assume the name of Adie Bros., Limited, following the voluntary liquidation of the 80 years' old firm. The old traditional craft methods are to be retained, while production and distribution are to be modernized to accord with changed conditions in the trade and in markets. The company is recognized as the largest exporters of silver and gold ware in Great Britain, and has sent 70 per cent. of its production overseas since the war. It is hoped further to develop the export trade. The firm made the silver tea set which was Birmingham's wedding present to the Queen, and a gold tea and coffee set worth £35,000 for ex-King Farouk in 1951.

Index to Vol. 94

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

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

(Delivered unless otherwise stated)

September 9, 1953

PIG-IRON

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

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

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

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

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

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

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

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered).

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

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

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

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

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

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

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

Cobalt.—98/99 per cent., 20s. per lb.

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

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

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

SEMI-FINISHED STEEL

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

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

Sheet and Tinplate Bars.—£25 11s. 6d.

FINISHED STEEL

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

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

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

Tinplates.—57s. 9d. per basis box.

NON-FERROUS METALS

Copper.—Cash, £230 to £233; three months, £215 to £216; settlement, £233.

Tin.—Cash, £616 to £618; three months, £609 to £611; settlement, £617.

Zinc.—September, £71 to £71 5s.; December, £70 17s. 6d. to £71.

Refined Pig-lead.—September, £95 10s. to £95 15s.; December, £91 10s. to £91 15s.

Zinc Sheets etc.—Sheets, 15 g. and thicker, all English destinations, £98 17s. 6d.; rolled zinc (boiler plates), all English destinations, £96 12s. 6d.; zinc oxide (Red Seal), d/d buyers' premises, £90.

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

Brass.—Solid-drawn tubes, 21½d. per lb.; rods, drawn, 31¾d.; sheets to 10 w.g., 245s. 3d. per cwt.; wire, 29¼d.; rolled metal, 232s. per cwt.

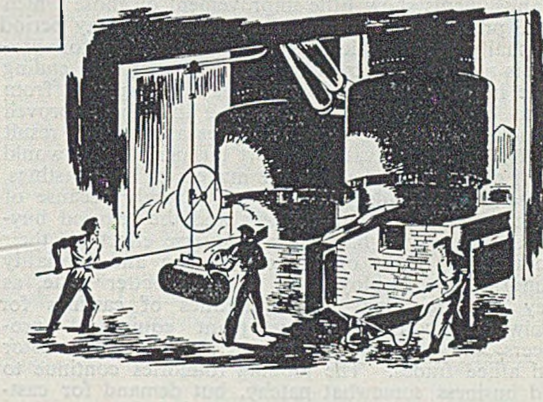
Copper Tubes, etc.—Solid-drawn tubes, 26⅜d. per lb.; wire, 258s. 9d. per cwt. basis; 20 s.w.g., 287s. 9d. per cwt.

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

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

Phosphor Bronze.—Strip, 344s. 9d. per cwt.; sheets to 10 w.g., 366s. 6d. per cwt.; wire, 43½d. per lb.; rods, 38d.; tubes, 36½d.; chill cast bars: solids 37½d., cored 38½d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Rolled metal, 3in. to 9in. wide × .056, 3s. 0¼d per lb.; round wire, 10g., in coils (10 per cent.), 3s. 5¼d.; special quality turning rod, 10 per cent., ½in. dia., in straight lengths, 3s. 4½d. All prices are net.



Raw Material Markets

Iron and Steel

Practically all the foundries have now resumed work after the annual holiday, but trading activities at many establishments show little improvement on those which ruled prior to the closure. The summer holiday period is usually accompanied by reduced business for producers and consumers alike, and now that it is ending some improvement in demand may be expected from home buyers. It is also expected that the improved financial outlook of some countries abroad will result shortly in the revival of export business. This would be of considerable help to the makers of light castings, whose export trade has been cut severely because of the closure of foreign markets, and the reduced buying at home also has had an adverse effect on their production. Most of the engineering and speciality foundries are employed on a much better scale, as they are providing good quantities of castings for steelworks, collieries, power-plant equipment producers, and machine-tool makers, as well as the motor and allied trades. The jobbing foundries continue to find business somewhat patchy, but demand for castings for the textile-machinery trade is brisker.

Foundries using high-phosphorus grades of pig-iron are able to obtain their requirements readily, although production is mainly confined to the lower silicon grades. Some increase in the demand for low-phosphorus iron has been forthcoming recently, but this is not attributable to improved business for castings, but to the fact that foundries which had not taken up supplies for some time are now finding it necessary to replenish their depleted stocks, sufficient, at least, to meet current consumption, as there is no change in their policy of buying only those tonnages which are needed to fulfil the work they have on their order-books. The producers of the low- and medium-phosphorus irons and hematite are able to dispose of their output with little difficulty, and more could be taken if production permitted. The makers of the refined grades could accept further business to absorb their full production.

Scrap supplies are adequate to meet the needs of the foundries, they experience no difficulty in obtaining their requirements of coke, ganister, limestone, and firebricks.

Most of the re-rollers are in need of orders to keep their plants operating at satisfactory levels. They have adequate supplies of most sizes of steel semis, apart from the smaller sized billets and special quality steels. Home demands for small bars, sections, and strip are very slow and export business has not improved to the extent expected when U.K. prices for merchant bars were reduced to a competitive level with those for foreign makers.

With few exceptions, rollers of heavy steel products have substantial programmes for the rest of the year, and if additional bookings are not coming forward quite so freely the outlook for the fourth quarter of the year is not unduly alarming. Consumers' stocks are believed to have been run down during the holiday period, and there are hopes of the raising of some of the restrictions on foreign trade. Home demand is still primarily focused on steel plate, but strong support is also forthcoming from the engineering, motor, and aircraft industries, and railway and colliery equipment is also in active demand.

Non-ferrous Metals

Markets have been quite active, trading in lead being particularly brisk, with a turnover larger than usual. It would not be right to say that the improved turnover is due to more participation by consumers, but there are some grounds for believing that trade is rather better and that we are beginning to feel the benefit of the usual autumn expansion of business. This is expected in the United States, where July and August are always quiet months so far as general trade is concerned, and metals must be included in this category. There has been a good deal of talk about a setback in America, and certain Wall Street sessions have suggested of late that "the pot is off the boil." Last week saw a sharp setback in zinc on the commodity market, although the producers' price remained at 11 cents. In London, sellers predominated and the price fell sharply, the market closing on Friday afternoon at the lowest point reached, *viz.*, £70 5s. This incidentally, was the lowest seen for three months or so. According to the Zinc Development Association, consumption of zinc in the U.K. during the first six months of this year was at the rate of about 14,800 tons, compared with 14,200 tons in 1952. Two years ago, however, the corresponding figure was 15,700 tons and in 1950, 19,700 tons.

Under heavy selling pressure, lead gave way and closed at the end of the week at £2 10s. for September and £1 2s. 6d. off for for the forward quotation. There has been persistent liquidation, and considering the volume of sales, the market stood up well to the battering it has had. Actually Friday brought some recovery, for the spate of selling eased off somewhat. Tin was erratic, but made a good recovery on Friday to close with a backwardation of £10 at £615 for cash and £605 for three months, these prices showing a gain of £2 10s. in cash and a loss of £2 in forward.

The fact that copper ended the week without any change on balance at £228 cash and £212 three months does not mean that no movements took place in the quotation between one Friday and the next. At one time the cash quotation was up to £232 10s. and there was a considerable variation in the spread between buyers and sellers of cash as well as of three months. While the producers in the United States maintained their prices unchanged, some fairly wide fluctuations were seen on the National Commodity Exchange, where futures are quoted.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* September 3, £223 to £230; September 4, £226 to £228; September 7, £230 to £235; September 8, £230 to £232 10s.

Three Months: September 3, £213 10s. to £214; September 4, £211 10s. to £212 10s.; September 7, £214 to £215; September 8, £216 to £217.

TIN, Standard—*Cash:* September 3, £623 to £625; September 4, £610 to £612 10s.; September 7, £615 to £617 10s.; September 8, £618 to £620.

Three Months: September 3, £612 10s. to £615; September 4, £600 to £602 10s.; September 7, £607 10s. to £609; September 8, £611 10s. to £612 10s.

ZINC—*September:* September 3, £71 5s. to £71 10s.; September 4, £70 10s. to £70 12s. 6d.; September 7, £70 5s. to £70 7s. 6d.; September 8, £70 15s. to £70 17s. 6d.

December: September 3, £71 5s. to £71 10s.; September 4, £70 7s. 6d. to £70 12s. 6d.; September 7, £70 7s. 6d. to £70 10s.; September 8, £70 12s. 6d. to £70 17s. 6d.

LEAD—*September:* September 3, £95 to £95 10s.; September 4, £94 to £94 5s.; September 7, £94 10s. to £95; September 8, £95 to £96.

December: September 3, £91 to £91 5s.; September 4, £89 to £89 5s.; September 7, £90 5s. to £90 10s.; September 8, £91 5s. to £91 10s.

[The prices for yesterday (Wednesday) are shown on the Price List on p. 346.]

Forthcoming Events

SEPTEMBER 15

Institution of Production Engineers

Coventry Graduate Section:—Production Panel: Discussion on Some Aspects of Production Engineering. 7.30 p.m., at The Hare and Squirrel Hotel, Cow Lane.

SEPTEMBER 16

Incorporated Plant Engineers

Glasgow Branch:—" Education and the Plant Engineer," 7 p.m., at the Scottish Building Centre, 425/427, Sauchiehall Street.

Institution of Production Engineers

Birmingham Section:—" The Ethics of Production," by R. W. Mann, M.I.Prod.E., M.I.E.E., M.I.Min.E., 7 p.m., at the James Watt Memorial Institute, Great Charles Street.

Institute of Vitreous Enamellers

Visit to Engineering, Marine and Welding Exhibition and Chemical Plant Exhibition at Olympia, London.

SEPTEMBER 18-27

Conference of the International Scientific Film Association at the National Film Theatre, South Bank, London, S.E.1.

SEPTEMBER 19-26

International Foundry Conference, Paris.

SHORT-WAVE RADIO TELEPHONE SETS are to be fitted to fork-lift trucks and electric goods-carrying vehicles used at the Jaguar car factory at Coventry, to increase the efficiency of the company's internal transport. Eleven sets having a range of five or six miles, and each costing £85, are to be used. The company is the first in the Midlands to adopt such a system.

Obituary

MR. JOHN HENRY GOURLEY, founder, chairman and managing director of the Wombwell Foundry & Engineering Company, Limited, near Sheffield, died on September 1, aged 76.

MR. CHARLES NORTH WRIGHT, who was a director of Tarmac, Limited, Wolverhampton, has died. He was also a director of Ernest N. Wright, structural engineers and ironfounders, of Wolverhampton.

The death has occurred of MR. PETER JOHNSTON, who, before he retired about 20 years ago, was head foreman plumber with the old Palmers Shipbuilding & Iron Company, Limited, at Jarrow and Hebburn.

MR. ERNEST WILLIAM BOHLE, a founder of J. A. Phillips, Limited, Smethwick, has died at his Birmingham home, aged 82. The firm began in small premises in Newhall Street, Birmingham, in 1892, and, together with Mr. J. A. Phillips, Mr. Bohle developed it into a growing concern. In 1908 the firm, J. A. Phillips & Company, Limited, was transferred to its present headquarters at Credenda Works, Smethwick. It now employs 4,000 operatives and has four factories. Mr. Bohle was formerly chairman and managing director.

Recent Wills

GRYLIS, LT.-COL. HENRY LEATHER, of Springwood, Whitechapel Road, Cleckheaton, formerly of Lenharic, Hightown, Liversedge, Spenborough, managing director of William Bywater, Limited, textile machine makers, Sweet Street Foundry, Leeds £16,871

SWINBURNE, ROBERT WALTON, of Ingfield House, Stocksbridge, near Sheffield, late stainless steel department engineer with Samuel Fox & Company, Limited, Stocksbridge £18,021

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

PATTERNMAKER, age 39, first class experience; present position, Chief Patternmaker with textile firm in India. Returning U.K. first week in October, 1953, requires responsible position, pref. Representative position. — Box 3679, FOUNDRY TRADE JOURNAL.

ARC FURNACE METALLURGIST (age 26), experienced in modern production methods, stainless, heat resisting, tool steels, seeks responsible position at home or abroad. Advancement in present post limited.—Box 3737, 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.

METALLURGIST (aged 30) desires progressive position. Extensive experience, common, high duty and alloy cast iron. Accustomed complete control of cupolas, sand, and laboratory.—Box 3741, FOUNDRY TRADE JOURNAL.

FOUNDRY MANAGER, A.M.I.B.F., desires change. 30 years' experience in all foundry practice; mechanisation; light and heavy castings for machine tools up to 5 tons; crank cases, etc.; cylinder heads; ext. for diesel engine, etc.; rate fixing, costing, and all foundry finance. Used to being in complete charge.—Box 3739, FOUNDRY TRADE JOURNAL.

METALLURGICAL TECHNICIAN (age 26), Int. City and Guilds, 10 years' practical experience in chemical analysis of ferrous and non-ferrous alloys, physical testing, heat treatment, chemical analysis of electroplating solutions, conversant with general engineering metallurgical problems, desires a post of responsibility in the Metallurgical field.—Box 3738, 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.

YOUNG DRAUGHTSMAN required, preferably with some knowledge of foundry work, to train as ASSISTANT to Manager of a Monmouth Foundry.—Apply, giving full details of experience and salary required, to G. P. SANDERSON, LTD., 107, Jermyn Street, S.W.1.

DIE DESIGN DRAUGHTSMAN required. Fully experienced on gravity and pressure die design.—Write giving full details of experience and salary, to MARSHALL CASTINGS, LTD., Mount Street, Nechells, Birmingham, 7.

SITUATIONS VACANT—*contd.*

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

CORESHOP FOREMAN required for Mechanised Foundry. Must be capable of handling labour and experienced in production of high quality cores for specialised repetition castings in High Duty Cast Iron. Apply by letter giving full particulars of age, experience and salary required to G. CLANCEY LTD., Belle Vale, Halesowen.

FOUNDRY in S.W. London requires active full-time sales representative in the Midlands with connections in the trade. Capable of organising sales effort and preferably with working knowledge of up-to-date foundry practice. Progressive position and adequate salary to successful candidate.—Box 3745, 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.

PRODUCTION CONTROL.—ENGINEER required to take charge of Office Planning Foundry, Machine and Assembly Shop. A.M.I.Prod.E. or equivalent. Drawing office, shop and foundry production control experience essential, including planning, scheduling, progressing, etc. Able to supervise staff. Age under 40. Complex but interesting work. Excellent prospects for man with right experience and ability.—Write, stating age, education, experience, qualifications and salary required, to Box 3740, FOUNDRY TRADE JOURNAL.

SALES MANAGER

required by well-known ironfounders producing light and medium grey iron engineering castings.

Applicants should be between 35 and 55 years of age, have an all-round knowledge of the trade and be able to obtain substantial orders. A first-class man is required.

Salary according to qualifications and experience.

Our own staff are aware of this advertisement, and all replies will be treated in the strictest confidence.—Box No. 3720, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*contd.*

SKILLED MOULDERS and CORE-MAKERS wanted. Top rates of pay and bonus. Council house within reasonable area, can be exchanged.—THE HIGH WYCOMBE FOUNDRY CO., LTD., Chapel Lane, Sands, High Wycombe.

WANTED: Chargehand Cupola Operator, experience of continuous casting essential. Must be capable of working with cupolas 2 ft. 6 in. to 5 ft. dia. Canteen and washing facilities provided. Payment for overtime. Apply stating experience and wages expected. Applications to—Box 3744, 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.

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.

ASSISTANT TECHNICAL SECRETARY: To assist in the provision of secretarial services to the Association's committees and panels and with the production of its internal publications. Applicants should be educated to degree standard, and experience in the field indicated will clearly be an advantage.
Applications, which in the first instance will be treated as confidential, should be addressed to: The Director, BRITISH STEEL CASTINGS RESEARCH ASSOCIATION, Broomgrove Lodge, Broomgrove Road, Sheffield, 10.

FOUNDRY PRODUCTION MANAGER wanted by Company operating both Floor and Mechanised Foundries in London area. Successful applicant must be a first class foundry technician with progressive ideas and the technical knowledge and experience to back them up. Diploma of National Foundry College or Degree in Metallurgy an advantage but not essential. A salary of not less than £1,000 per annum (more for special qualifications) plus bonus on results and generous conditions of service will be given to successful applicant. First application to include (in confidence): (*a*) Experience, positions held, salary received, and description of duties carried out. (*b*) Special knowledge, *e.g.* (i) Mechanical Plants, (ii) Machine Tool Work, (iii) Rainwater and Soil, etc., etc. (*c*) Education, course of study or apprenticeship. (*d*) Degrees and Diplomas held. (*e*) Membership of Professional bodies, etc. (*f*) Age. (*g*) Salary expected. (State existing). (*h*) When available for interview and commencement if successful.—Box 3707, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*contd.*

YORKSHIRE STEEL FOUNDRY requires experienced man for sand control and experimental sand mixtures. Full details of experience, age, etc., to Box 3717, FOUNDRY TRADE JOURNAL.

TECHNICAL AND SALES REPRESENTATIVES for Scotland, Wales and Manchester districts for Industrial Furnaces, especially Foundry Drying Equipment and all kinds of Heat Treatment and Reheating Furnaces. Excellent position for keen engineer. Salary plus commission offered.—Box 3726, FOUNDRY TRADE JOURNAL.

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.

YOUNG TECHNICIAN (preferably aged 23/28) required by a large Steel Foundry for technical control (and possibly, later on) development work. The initial duties would consist of the running of a radiographic department and experience of industrial radiography would be a great asset. Replies stating educational details, experience to date and salary desired should be sent to Box 3708, 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.

FOUNDRY MANAGER required for partly mechanised Foundry. Rainwater and Engineering Castings up to 6 tons. Approximately 500 employees. Applicants must have excellent production and administrative ability, with good technical background. State age and full details of experience and salary expected. House goes with the appointment.—Write 2587, WM. PORTEOUS & Co., Glasgow.

A SUBSTANTIAL Engineering Company in the North of England requires a first-class and fully qualified CHIEF TECHNICAL OFFICER, whose duties will be to control metallurgical activities and to supervise the development of processes chiefly connected with the heavy industries.—Applicants are requested to send full particulars in confidence to MANAGING DIRECTOR.—Box 3728, FOUNDRY TRADE JOURNAL.

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.

SITUATIONS VACANT—*contd.*

FOUNDRY FOREMAN, age 30/35, experienced in ferrous and non-ferrous machine moulding, hand moulding and sandrammer practice, required for Middlesbrough Foundry. — Box 3706, FOUNDRY TRADE JOURNAL.

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

METALLURGIST wanted for Tyneside Jobbing Ironfoundry making Meehanite High Duty Castings. Please state experience, salary required, and when available.—Box 3731, FOUNDRY TRADE JOURNAL.

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.

AGENCY

WELL-ESTABLISHED London company, with West End office and sales staff, sole Representatives for well-known provincial ferrous foundry, will consider similar appointment for Die Casting Foundry with machine shop having London and Home Counties connections.—Box 3667, FOUNDRY TRADE JOURNAL.

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MACHINERY WANTED.

(1) Sandslinger. 9 ft. Radius Arm. 440/3/50.

(2) 16 in. dia. Abrasive Disc Cutting Machine. Suitable for Fettling. 440/3/50. Box 3735, 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, 4,000 lb. Pneulec-Herman Jarr Rollover Pattern Draw Machine. State age, condition and price required to K. & L. STEELFOUNDERS & ENGINEERS, LTD., Letchworth, Herts.

10 MOULDING BOXES, 30 in. by 36 in. by 6 in. by 3 in., required for machine moulding. Must be in excellent condition. — Box 3714, FOUNDRY TRADE JOURNAL.

WANTED—Foundry Rumbling Barrel, approximately 6 ft. 0 in. to 7 ft. 0 in. long, 3 ft. 6 in. to 4 ft. 6 in. diameter.—FELLING FOUNDRY, LTD., Abbotsford Road, Felling-on-Tyne. Telphone 82404.

RETIRED GENTLEMAN desires to purchase Moulds, Patterns Garden Ornaments and Illustrations of Bronzes, Medieval Knights in Armour, Cavaliers in ½ and ⅔ life size. Ex Film Studio Models in Wood, Metal, etc., of early Elizabethan and Cromwellian Period. — Apply to S.M. & R., Hooper Street, Cambridge.

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600-c.f.m., TILGHMAN, vert., single cyl., single stage, watercooled, type F.C.9. Speed 365 r.p.m., w.p. 60 lb.

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600-c.f.m., BROOM & WADE, vert., encl., single stage, watercooled, 4-cyl. speed 310 r.p.m., w.p. 100 lb. "V" belt driven from 6-cyl. Heavy Oil Engine, by Waukesha, radiator fan cooled, with inbuilt Petrol Engine starting unit.

600-c.f.m., BROOM & WADE, vert., single stage, watercooled, 3-cyl., speed 310 r.p.m., w.p. 100 lb. Driven from 125 h.p. S.R. Induction Motor, by Crompton, 380-415/3/50, with Starter.

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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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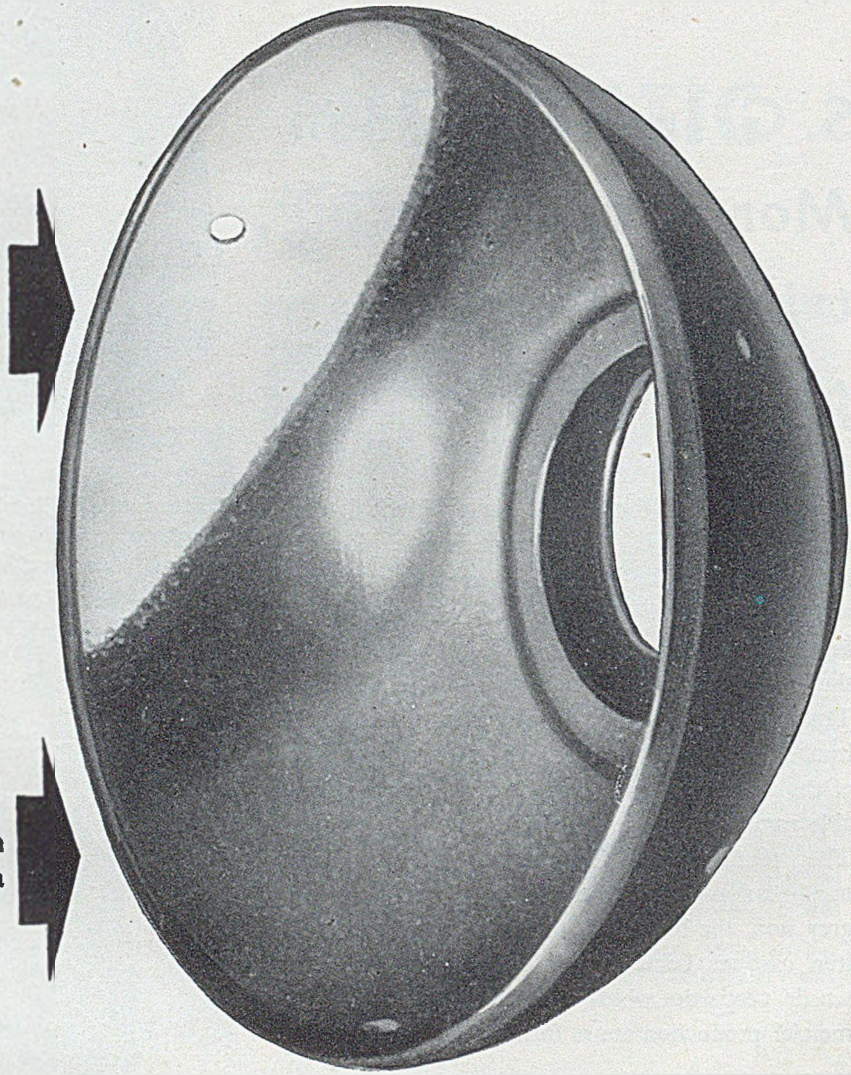

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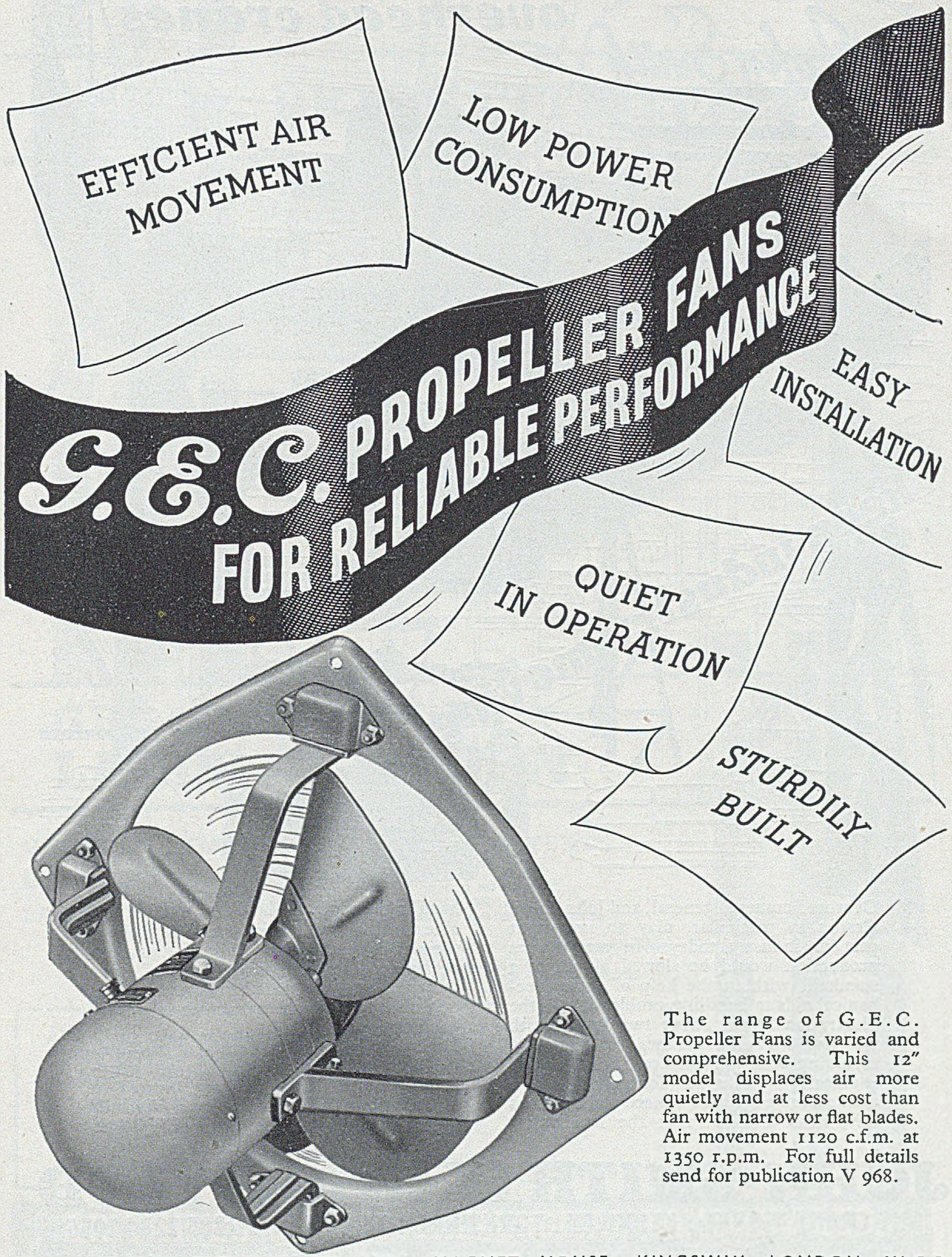
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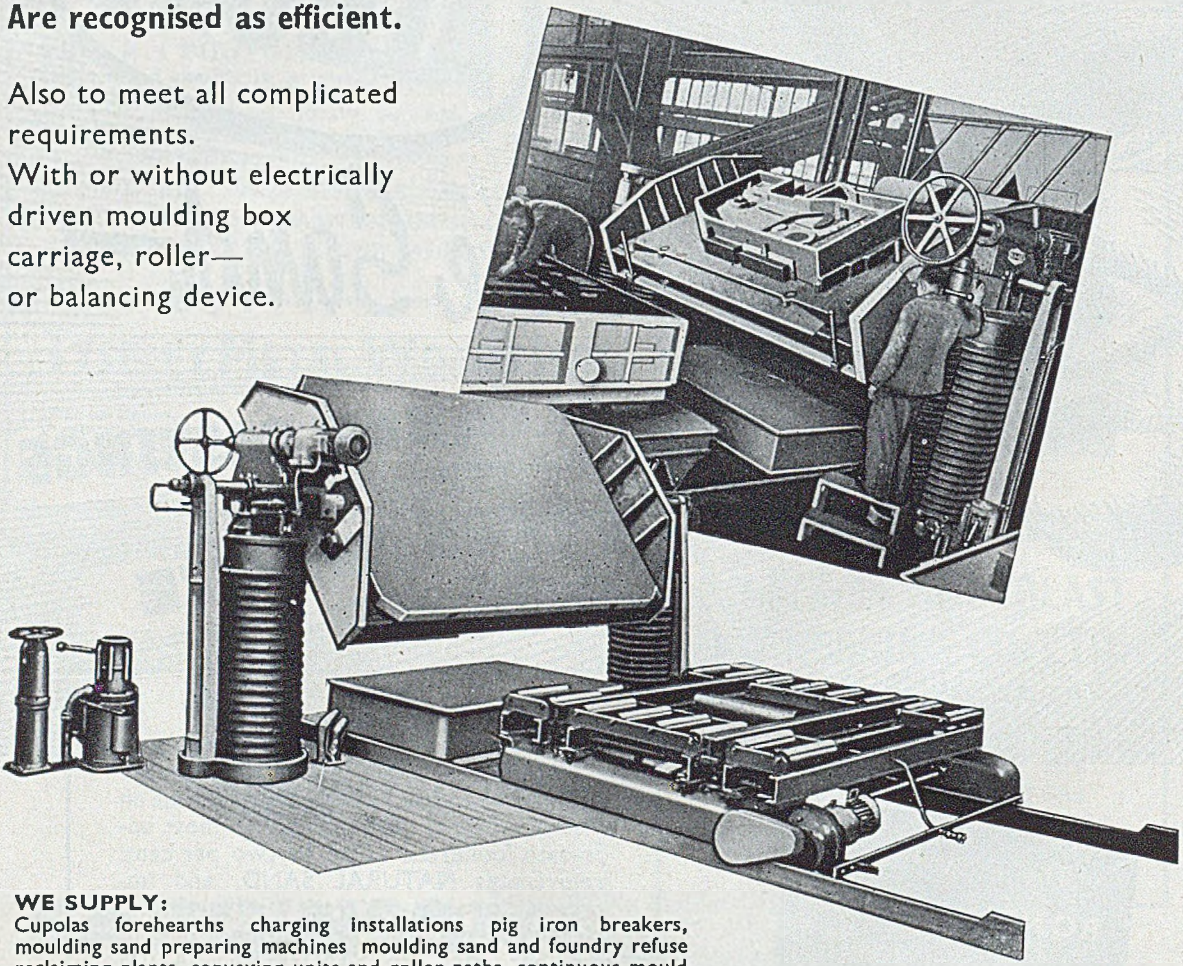

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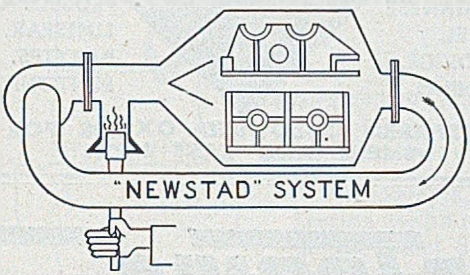

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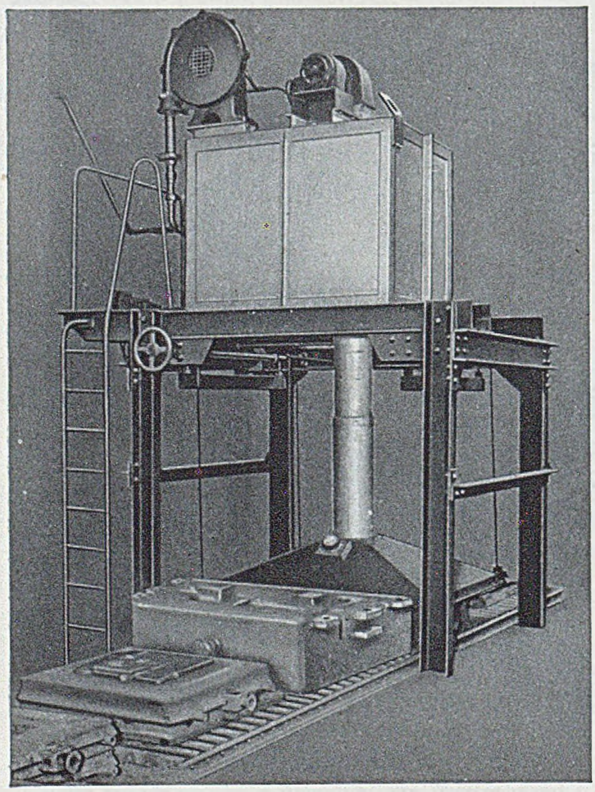

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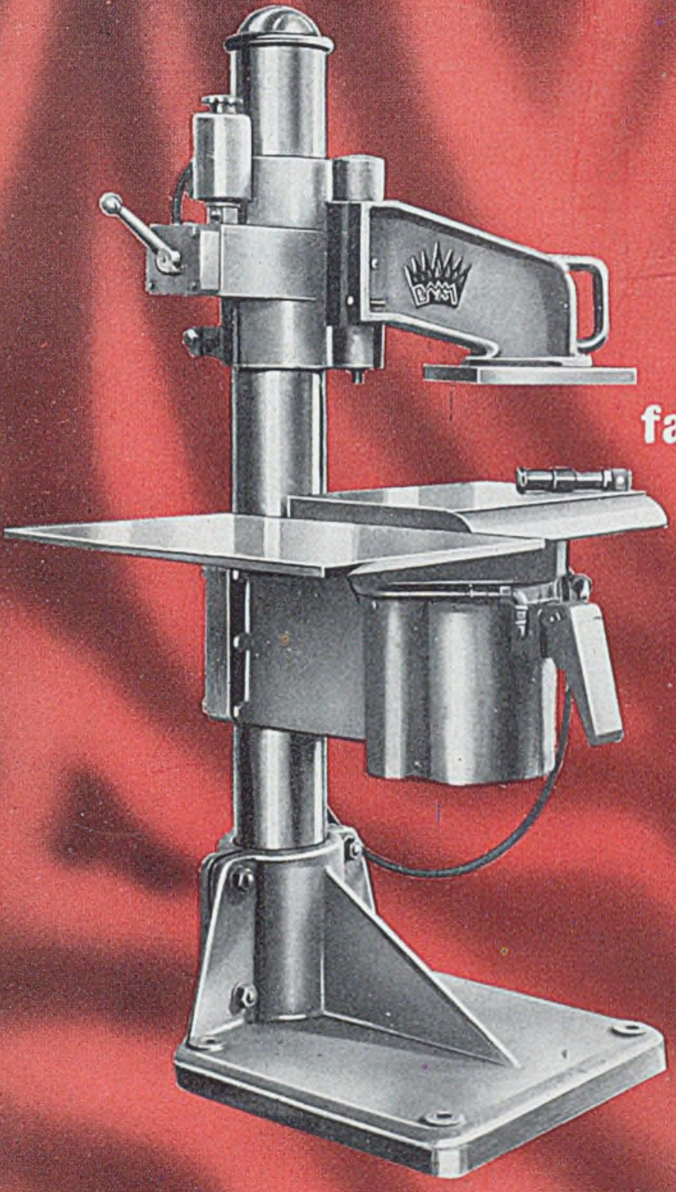

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