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Platitudes *versus* Technology

We are beginning to feel a sense of nausea each time our mail disgorges yet another pamphlet on management. In them we find a collection of platitudes, which with the passage of time tend to suggest the pulpit rather than the chairman's little table for their delivery. We believe the time is ripe to inform the management pundits that unless they have something really new to disclose, they would be better employed in some more practical social activity—the Boy Scout Association, the Y.M.C.A., or the like. The underlying principles of works management are by now well known. Examples as applied to individual firms or industries have been given, but, unfortunately, industries vary so much in character and in their labour agreements that application is well nigh impossible. One book on the subject recently arrived and details were given of the organisation of some of the largest undertakings in the country. The systems disclosed are about as much good to the average managing director as toothache.

Groups of individuals vary as greatly as the individuals themselves. The management of a works characterised by the employment of a staff of local people, most of whom have long service to their credit, is vastly different from one utilising large cadres of Italian, Polish, Irish, or Indian labour, or, indeed, where during a war there is an influx of raw labour with the inclusion of " spivs " and the like. In this last case, the man in charge of such labour has to be " quicker on the uptake " than men who have habitually " lived on their wits."

The whole weakness of the generality of these lecturers on management is that they can, like most other people, recapitulate historic conditions and give advice reminiscent of a vegetable pie—that is—devoid of meat. " Crusading spirits," " promotion of common good," " group responsibility," and suchlike phrases interlard the average management talk. If there be a demand for such sermons, then we suggest, like the Government to the non-munition industries during the war, that they be concentrated into one body. Not only are there several associations, institutes, and the like covering management, but the topic is entering the lecture programmes of some of the well-established technical institutes. We are reasonably certain that the Institute of British Foundrymen, through its organisation of foremen's conferences, has done more towards the creation of good management within its own industry than would attendance at whole series of " pep " talks on management. Again, the Productivity Conferences organised by the British Steelfounders' Association have achieved a similar purpose, because—and this is important—the practice of good technology is closely to be associated with good management. Psychological benefits will arise from the mutual discussion of technology. The best " management " papers are those involving a maximum of technology and a minimum of platitudes.

Contents

I.B.F. National Works Visits

First Arrangements under New Scheme

The Institute of British Foundrymen has recently decided to add to its activities by organising, annually, a day to be devoted to works visits open to all members of the Institute. The opportunity to participate in these visits will supplement the arrangements which are already made by the branches and at the annual conferences, and will also give an opportunity to those members who cannot spare the time to attend the whole of the annual conference to take part in an annual national gathering. It is hoped that these annual gatherings will be organised by each of several of the branches in turn. The Birmingham branch has agreed to be responsible for the arrangements for the inaugural day of works visits, and the arrangements made for the meeting on Friday, October 6, are as follow:—

1. A large number of important foundries in the Birmingham area have kindly agreed to participate and to receive parties of members. These foundries have been divided into groups of two and members are asked to indicate which group they wish to join and also indicate first and second reserves.
2. Each group of visits will consist of a visit in the morning and a visit in the afternoon. Luncheon will be provided at some suitable place at mid-day.
3. Members participating will assemble at the Imperial Hotel, Temple Street, Birmingham, at 9 a.m. The groups will leave at 9.45 a.m. and will return to the Imperial Hotel at from 5 to 5.30 p.m.
4. In the evening there will be a dinner and a smoking concert at the Imperial Hotel. Tickets are limited to 200 in number.

Programme

Works to be visited by kind invitation of the directors and managers of each company.

Party.	Morning visit.	Luncheon.	Afternoon visit.
A.	H. W. Lindop & Sons, Ltd., Walsall (malleable iron founders)	George Hotel, Walsall	F. H. Lloyd & Co. Ltd., Darlaston (steel founders)
B.	Beans Industries, Ltd., Tipton (iron, founders, including automobile cylinder blocks	Station Hotel, Dudley	F. H. Lloyd & Co., Ltd., Darlaston (steel founders)
C.	William Mills, Ltd., (aluminium founders)	New Inns Hotel, Handsworth	Simplex Electric Co., Ltd., Oldbury (iron and malleable repetition founders)
D.	Midland Electric Manufacturing Co., Ltd., Tyseley (highly-mechanised iron foundry)	Airport Hotel, Elmdon	Ford Motor Co., Ltd., Leamington Spa (iron and steel agricultural castings and automobile castings)
E.	Belliss & Morcom. Ltd. (high-speed steam-engine, grey-iron foundry)	Airport Hotel, Elmdon	Sterling Metals, Ltd., Nuneaton (light, magnesium- and aluminium- alloy castings for automobile aircraft and general engineering)
F.	Austin Motor Co., Ltd., Longbridge (automobile castings)	Austin Motor Co.	Parkinson Stove Co., Ltd., Stechford (cooker castings)
G.	Austin Motor Co., Ltd., Longbridge (automobile castings)	Austin Motor Co.	Dartmouth Auto Castings, Ltd., (automobile castings)
H.	B'ham Aluminium Castings Co., Ltd., (aluminium founders)	New Inns Hotel, Handsworth	Rudge-Littley, Ltd., (general iron foundries) and the National Foundry Craft Training Centre at Swan Village)

The charge for each group of works visits, including transport, coach, luncheon, etc., as well as administration expenses, is 22s. 6d. The additional charge of the evening dinner and smoking concert is 12s. 6d. Members who desire to participate are requested to make formal application to the Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, 3, not later than Saturday, September 9—earlier if possible. In order to provide accommodation for visitors from other branches the Birmingham branch has agreed to limit the number of their own members in each group. Bookings from all other members will be allocated strictly in the order in which they are received. Members participating are requested to make their own arrangements for hotel accommodation, and are advised to book early.

Latest Foundry Statistics

The June Bulletin of the British Iron and Steel Federation reports that during the month of May, employment in iron foundries rose to 146,978, an increase of 379, made up of 325 men and 54 women. A year ago the industry was employing 798 more people, of whom 203 were females. There has also been a slight increase in employment in the steelfoundry industry; at 19,308 on May 6, the gain registered over April was 76. A year earlier the industry employed 224 more workpeople, of whom 21 were female. The quantity of liquid steel melted for the making of steel castings in May showed a weekly average of 8,500 tons, an increase of 500 tons over April, but a decrease of 300 tons as against May, 1949. The weekly output of finished steel castings has been averaging 4,700 tons over the first five months of this year, of which 1,000 tons were alloyed. Confined to May, however, these averages were 4,400 and 900 tons. The weekly average in 1948 was 2,700 tons.

THE COUNCIL OF INDUSTRIAL DESIGN, Tilbury House, Petty France, London, S.W.1, is again appealing to manufacturers to supply photographs, 8 by 6 in., of products of which they are most proud. These must reach the Council before August 1, so no time must be lost.

BRITAIN'S SCHOOL OF GAS-TURBINE TECHNOLOGY—the only one of its kind in the world—is re-opening at Farnborough Place, Farnborough, Hampshire, in October. The school, maintained by Power Jets (Research & Development), Limited, has been moved because of expansion from its old premises at Lutterworth where Air Commodore Sir Frank Whittle's team designed and tested some of the earliest jet engines.

THE DEATH has occurred of Mr. G. D. Broadbent, London manager of John Harper & Company, Limited, of Willenhall. He was well known and much liked by a very large circle of friends in the South of England. In many ways he was the ideal representative for the sale of castings, as he possessed a wide knowledge of the properties and use of such products, coupled with real business ability. His early demise has cut short a career which was full of promise.

DETAILS given in the report of the British Chamber of Commerce of Sao Paulo and Southern Brazil relate to the growing importance of the iron and steel works at Volta Redonda. Production at Volta Redonda during 1949 reached the following totals:—Pig iron, 192,774 metric tons; steel, 308,188 tons; rolled products, 225,887 tons. It is hoped to produce 390,000 tons of pig iron during the current year, and the output of rolled products is expected to be in the region of 308,000 tons. The Volta Redonda plant also produced 271,710 tons of coke.

Fluidity of Steel*

By. J. E. Worthington, B.Sc.

Fluidity is a subject on which much work has been concentrated. It is now generally agreed, however, that the use of a standard spiral test-piece is best suited for the determination of fluidity. Previous work has always been subject to some error, due to the rate of pouring the test-moulds not being accurately controlled. A method of standardising the pouring speed is described, and some of the results obtained are given. The curves so produced all exhibit a characteristic break, a fact which has only once previously been reported,[14] due probably to the degree of scattering always obtained when the pouring speed is not controlled. The way in which the fluidity of steel varies with different carbon contents is shown. The fluidity of some alloy steels has also been given, and the results discussed.

THE BIBLIOGRAPHY on the fluidity and the viscosity of metals, published by the Iron and Steel Institute in 1936, contains no less than 105 references. To this long list many later additions can be made. It is apparent, therefore, that a great deal of work has been done and much thought has been given to this subject, and the volume of this work may also serve as a sign of the difficulties to be encountered in attempting to resolve the question why some metals flow more freely than others.

Fluidity, as understood by the foundryman, is not a simple physical characteristic, such as the reciprocal of viscosity, which is the physicist's definition of fluidity. The intrinsic property of a metal which determines its fluidity is probably fairly simply related to its physical properties of viscosity and surface tension, though it is possible that other internal factors such as the type and extent of suspended inclusions and the composition of the alloy as affecting its mode of solidification, may have a profound effect. Any actual determination of fluidity is, however, also dependent upon a number of external factors, such as the temperature and thermal characteristics of the mould, the rate of pouring and the ferro-static pressure applied to the liquid metal. Numerous earlier publications on this subject have indicated the significance of these factors.[1 2 3 4 5 6] The main advance in the present investigation has arisen from a much closer control of the external factors, and in particular the rate of pouring, and as a consequence the results have been far more reproducible, and they are probably a truer measure of the intrinsic fluidity of the steel compositions examined.

Development of Methods

A comprehensive account of the methods used for determining fluidity was given at the 43rd Annual Conference of the Institute of British Foundrymen by K. L. Clark,[7] and there is no need therefore for further repetition, though mention should be made of the method developed by Sanders and Kain[8] who introduced a test-piece, designed to approximate more closely to commercial casting conditions. It is now generally agreed that the determination of fluidity is best accomplished by measuring the length of flow obtained in a narrow channel mould, which has been fed from a constant height, under a constant pressure head, and into which the metal has been introduced at a constant rate.

Two types of mould have been developed using this principle, one having a straight-flow channel, and the other a spiral flow channel. The straight-flow channel was first introduced by Ruff[9] whose test-mould has been used, with modifications, by several subsequent investigators. The spiral-type test-mould was originally proposed as an instrument for measuring fluidity by Saito and Hayashi,[10] though Saegar and Krynitsky[11] first put such a test on a fixed working basis. The design of this test-piece has also been modified by various investigators, the most notable adaptations being those of Andrew, Percival and Bottomley,[12] and of Taylor, Briggs and Rominski[13]; in both of the latter, test-moulds were designed to control the height of metal in the pouring basin to within one quarter of an inch.

Whilst theoretically the straight Ruff test-piece would appear preferable, the practical advantages all seem to favour the spiral-type mould. The outstanding features obviating the use of the straight-flow channel are the length of the mould required, and the necessity for extreme accuracy in levelling the mould. The cross-sectional area of the straight-flow channel has necessarily been restricted in order to keep the mould length within convenient dimensions. Whilst therefore lengths of approximately 60 in. are possible using the spiral-

* Paper presented at the Annual Conference of the Institute of British Foundrymen. The Author is on the staff of the British Iron and Steel Research Association and is stationed at Sheffield University.

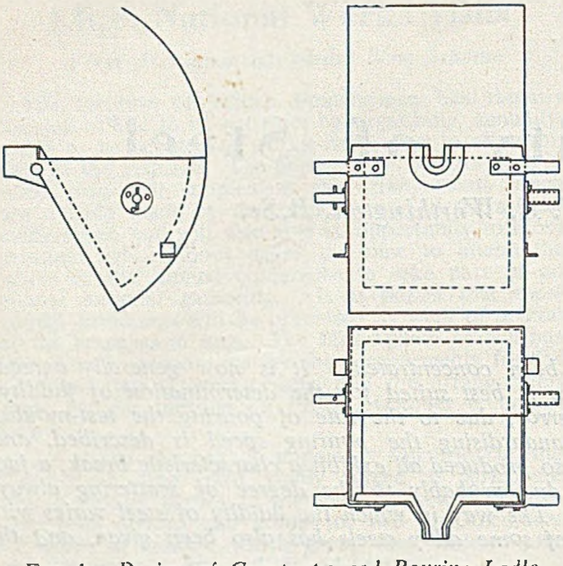


FIG. 1.—*Design of Constant-speed Pouring Ladle.*

type mould, the length of the straight-flow channel does not exceed 24 in. It is probable, therefore, that the spiral test-mould will record differences in the length of flow of steel through a sand mould, which would be imperceptible if the straight bar were employed.

Comparing the spiral-test channel used by Taylor, Briggs and Rominski, with that adopted by Andrew, Percival and Bottomley, the former had a cross-sectional area of $\frac{1}{4}$ sq. in. as against $\frac{1}{16}$ sq. in. for the latter. Longer spirals would therefore be expected, together with an accompanying increase in sensitivity, when using the Taylor, Briggs and Rominski spiral, and it was therefore decided to adopt this test mould in these investigations. The most probable cause of inaccuracy, which both the above spirals fail to control, was that no provision had been made to standardise the speed of entry of the metal into the moulds. It was decided therefore, in the new investigations, to control the pouring speed within narrow limits. A further question which had to be resolved was whether to make the moulds in green sand or in core sand. Due to the possibility of warping during drying if core sand were employed, it was decided to ram the moulds up in a standard green-sand mixture.

Control of the Pouring Speed

Various methods for controlling the pouring speed for the spiral moulds were envisaged, but the following method appeared to be the most practical. Essentially, the method adopted was to contain the molten steel in a ladle of such a shape that, provided it was tilted at a constant rate, the metal would be discharged at a constant rate. The ladle eventually designed was of approximately one hundredweight capacity and of the shape shown in Fig. 1. The two sides of the ladle consisted of segments of a circle, the lengths of the straight sides being each 12 in. long, and the angle between them 60 deg. These two sides were kept 12 in. apart by means of a plate 12 in. square, and the two opposing arcs were welded to a steel plate 12 in. wide by 25 in. long, which was bent to conform to the arc. One half of this back plate projected above the rest of the ladle, and thus served to protect the lifting and driving chains from excessive heat.

To this shell were bolted the front trunnions, as well as trunnions situated at the point of balance, and arranged so that lifting handles could be fitted to them at will. Two angle pieces were also welded to the shell, at such a height that when the ladle was supported on its front trunnions, a support under the brackets would keep the ladle on a level plane. The lining was rammed to the same shape as the shell by means of a wooden former of appropriate size. Mansfield red moulding sand was used for this lining, though the lip, for greater strength, was constructed from ganister. The lining, when given a wash with "Corefrax" paint, and carefully dried, was ready for use. To ensure that the correct shape was accurately maintained a new lining was installed for each heat of metal.

A carriage was constructed which supported the ladle by means of its front trunnions and supports, at a convenient height for pouring, and also housed a lifting and lowering mechanism. An electric motor, suitably geared down, was arranged to drive a sprocket wheel which could be engaged with the motor at will by means of a clutch system. Thus, when the clutch was engaged, the sprocket wheel rotated and this, by means of a chain attached to the ladle, passing over this sprocket wheel and kept taut by means of a weight, tilted

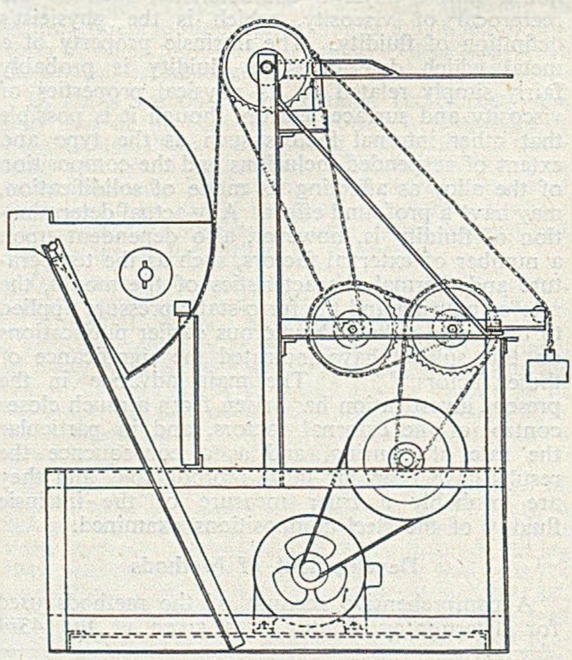


FIG. 2.—*Carriage and Mechanism for Operating the Constant-speed Pouring Ladle.*

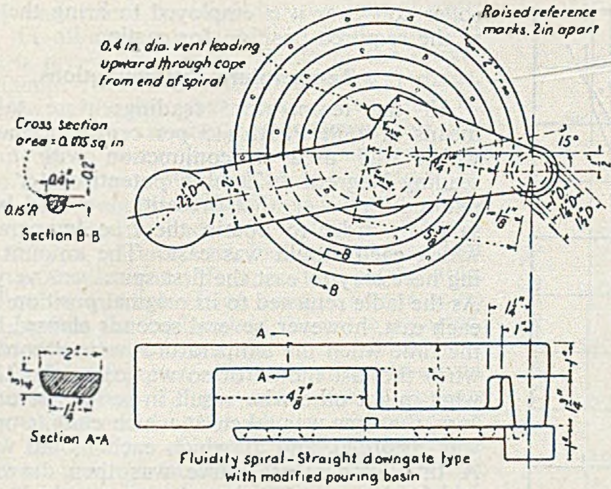


FIG. 3.—*Dimensions of the Taylor, Briggs and Kominski Fluidity Spiral.*

the ladle through the required angle. Disengaging the lifting clutch served, at the same time, to engage a sliding clutch, which helped to return the ladle to its static position, without excessive bumping and splashing. The speed of the rotation was such that a mould would be cast in approximately one second. The details of the carriage with the ladle in position are shown in Fig. 2.

Moulding Technique

The dimensions of the Taylor, Briggs and Rominski spiral are shown in Fig. 3. The pattern was fixed rigidly to an aluminium plate, and all the moulds were made on a moulding machine of a simple pattern-draw type. This ensured that the spiral mould conformed accurately to the pattern dimensions. The pattern of the spiral was slightly modified in order to simplify the pouring of the moulds. The position of the pouring basin, originally lay diagonally across the moulding box. This necessitated pushing the moulds well under the ladle for casting. In fact, when the ladle was nearly emptied, the moulds had to be pushed so far under that they prevented the ladle from returning to its neutral position. To avoid this, the basin was positioned so that it was located parallel to the side of the moulding box nearest to the ladle. This revised orientation considerably simplified the pouring of the moulds. The original and the revised positions of the pouring basin can be judged by reference to Fig. 4, which shows the original, and Fig. 5, showing the revised position.

The standard sand used in moulding was made up in the following proportions:—Arnold's 26A silica sand, 95; bentonite, 3; and water, 2 per cent.

Melting

The metal charges were all melted in a one-hundredweight capacity Birlec arc furnace, having two electrodes. The hearth was lined with silimanite, whilst the roof was constructed of silica bricks. Both plain carbon and alloy steels were melted, the melting technique being kept as constant as possible. Immediately prior to pouring, the steel was killed with aluminium, at the rate of 2 lb. of aluminium to one ton of steel melted. The silicon contents of the steels were somewhat variable. Values higher than had been estimated were invariably obtained and some reduction of

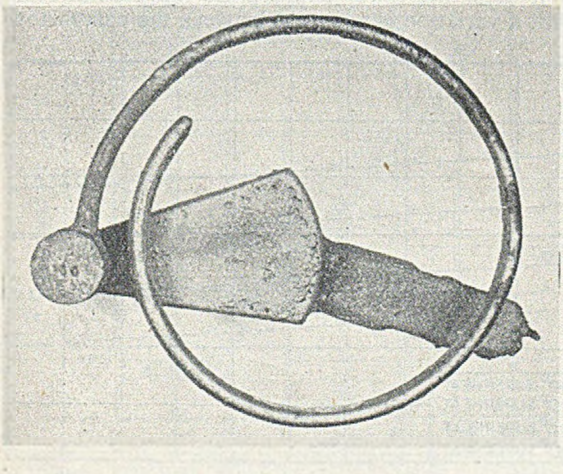


FIG. 4.—*Original Position of the Pouring Basin on the Fluidity Spiral.*

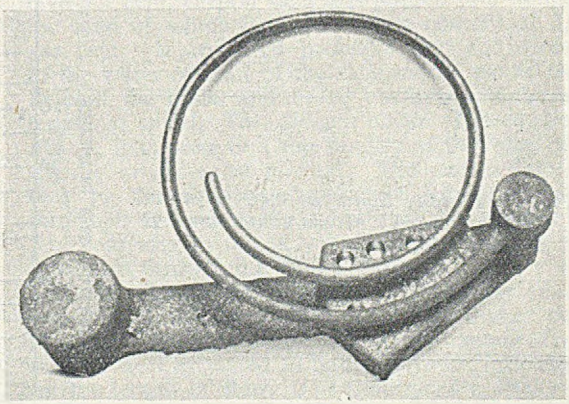


FIG. 5.—*Revised Design of Pouring Basin.*

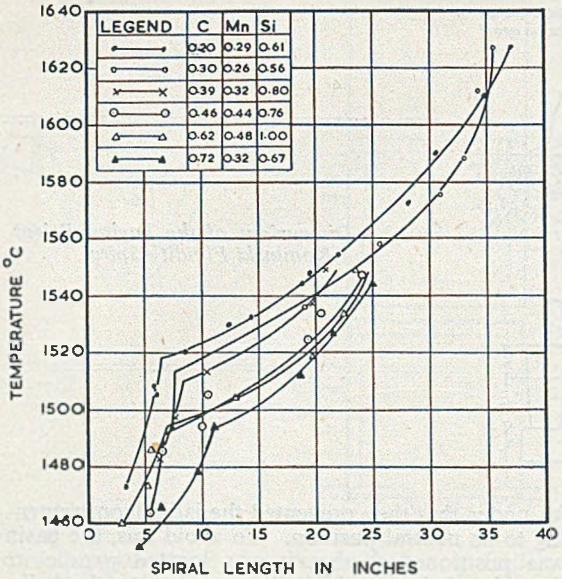


FIG. 6.—*Effect of Carbon on the Fluidity/Temperature Curves for Steel.*

silica had obviously taken place from the slag. The high temperature of the arc and the presence of carbon particles would favour such a reduction.

Casting

In casting, the following procedure was adopted. The ladle, heated to redness and fitted with its handles, was lifted by means of a crane, and taken to the furnace to be filled with steel. When full, the crane conveyed the ladle to its position over the carriage, where it was guided into its supports. The ladle handles were quickly detached, and the lifting chain was fastened to the lower edge of the ladle and made taut. Meanwhile, a thermocouple was dipped into the metal so that a temperature reading could speedily be obtained. The electric motor was started immediately the chain was attached to the ladle, and the first mould was placed into position for pouring. A length of roller conveyor was employed to bring the moulds to the required position for casting.

Temperature Determinations

All the temperature readings were taken by means of a Pt/Pt-Rh (13 per cent.) thermocouple, which was used in conjunction with a quick-reading Negretti & Zambra potentiometer. It was realised, however, that precautions would be necessary, in order to obtain the true temperature at which each mould was cast. The amount of tilting necessary to cast the first spiral was very slight. As the ladle returned to its original position between each cast, however, several seconds elapsed between the time when the temperatures were recorded, and when the last mould or so was cast. To eliminate what might otherwise result in serious errors therefore, the time was taken at which each temperature was recorded, and at which each mould was cast. A time/temperature curve was then drawn, from which the actual temperatures at which pouring occurred were extrapolated.

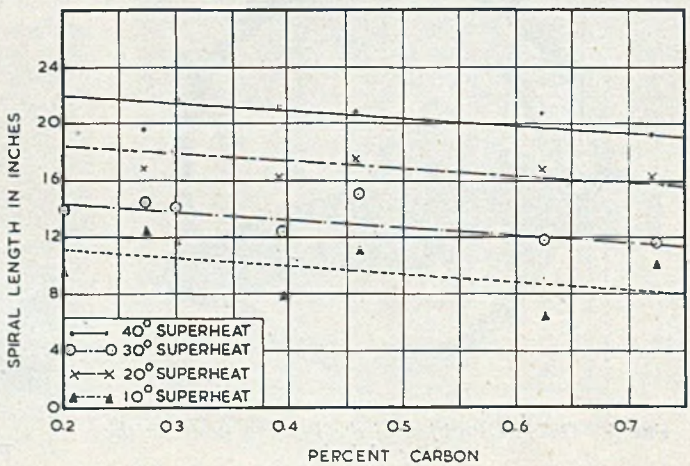
RESULTS

Effect of Carbon

Steels of varying carbon content were melted, and the fluidity-spiral lengths obtained from each heat of steel were plotted against the corresponding temperatures. The curves obtained are shown in Fig. 6. A comparison of these fluidity/temperature curves shows an increase in fluidity as the carbon content increases. It will be noticed that, at temperatures in the middle and higher ranges, all the curves shown are similar in shape to those obtained by Briggs and his co-workers. In the middle ranges, the length of run obtained varies almost in a linear relation to the temperature. As the temperature increases, however, the fluidity becomes progressively less, the length of run tending to reach a limiting value at a high temperature. Due to the cooling, by the comparatively-cold ladle lip of the first metal to be poured, the tailing off, apparent in the curves shown, may be somewhat accentuated.

It is in the lower temperature ranges, however, that a variation is apparent between the curves now

FIG. 7.—*Fluidity Spiral of 0.46 per cent. Carbon Steel in a Mould containing 3.92 per cent. Moisture.*



obtained and those reported by previous investigators. In all cases, a curve has been obtained showing a break or a cusp. Some of the curves were originally drawn having an inverted S shape, but in view of the fact that the majority could be drawn more easily in the shape shown, this has been done in all cases. A curve of a similar shape to those shown was obtained in one instance by Jackson, Knowles, Middleham and Sarjant.[14] The steel then referred to had been melted in a basic-lined induction furnace, and had a silicon content of only 0.07 per cent. It appeared conceivable, therefore, that this low silicon content was in some way responsible for the break in the curve reported. The silicon contents of all the steels which have been melted in the present investigation, however, ranged from 0.5 to 1.0 per cent., and it appears unlikely, therefore, that the above supposition is correct. The absence of such a break in the curves reported by previous investigators is probably due to the wide scattering of the points obtained, which would probably mask any such change in direction. It is apparent, however, that in the lower-temperature ranges, a restraining influence is in operation which inhibits the free flow of the steel. Exactly what this influence is, is not as yet understood. It is possible, however, that the surface tension of the steel, enhanced by the presence of surface-oxide films, is in some measure responsible for these deviations. Below a certain temperature, such a film may to some extent restrict the natural flow of the metal. Above this temperature, the physical nature of the film may alter and thus allow the metal to flow more freely.

"Melting-point-plus" Basis

It was appreciated that a more fundamental relationship connecting fluidity and carbon content would be obtained, were graphs of the carbon contents plotted against the spiral lengths, at specific

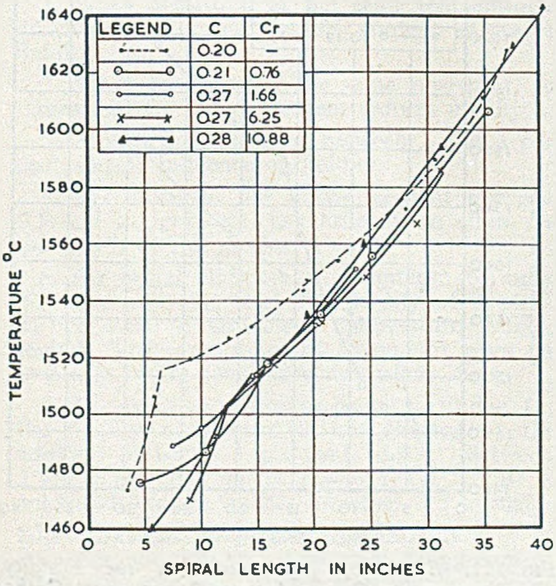


FIG. 8.—*Effect of Chromium on the Fluidity/Temperature Curves for Steel.*

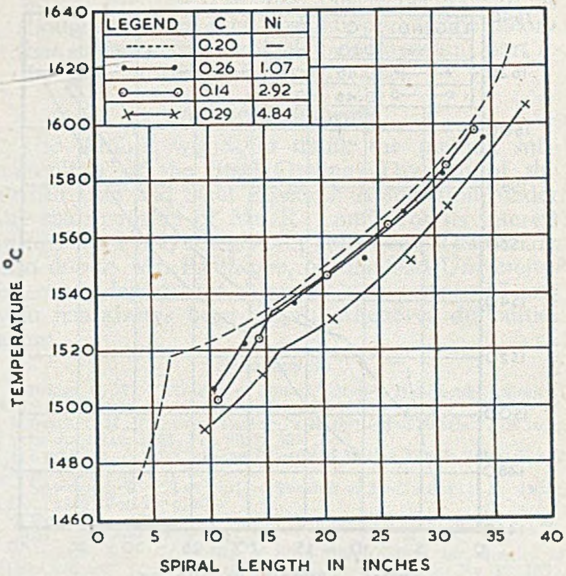


FIG. 9.—*Effect of Nickel on the Fuidity/Temperature Curves for Steel containing approximately* 0.2 *per cent. Carbon.*

temperatures above the corresponding liquidus temperatures. This was accordingly done for temperatures of 10, 20, 30 and 40 deg. C. above the liquidus. The resultant curves are shown in Fig. 7. It can be seen that on this basis the relationship of fluidity to carbon content is reversed and that, for a given step above the liquidus temperature, the fluidity decreases somewhat as the carbon content increases. This result is somewhat surprising but has to some extent confirmed Briggs' finding of a maximum fluidity for low-carbon steels, the fluidity decreasing somewhat at 0.3 per cent. carbon and being restored to an intermediate value at 0.6 per cent. carbon. It is also further supported by Portevin and Bastien,[15] who stated that fluidity varies inversely to the interval of solidification.

It would appear that the moisture content of the moulding sand, within the limits tried, has little or no effect on the length of spiral produced. The 0.46 per cent. carbon steel was poured into moulds, the sand of which had a moisture content of 3.92 per cent. It appeared probable that an increase in the water content of the sand mould would tend to chill the metal and hence produce a decreased length of spiral. This did not occur. Indeed, from Fig. 7, it is seen that the fluidity of this steel was slightly in excess of normal. The reason for this may be the almost instantaneous formation of a thin shell of steel on the mould face, as reported by Ruff,[9] or else in the very rapid rate at which the steel runs through the mould channel.

It has already been mentioned that the silicon contents of the steels were all rather higher than normal. The variation in the silicon contents from steel to steel appeared to have, however, little effect on the length of flow. The fluidity of a steel with 0.62 per cent. carbon, having a silicon content of 1.00 per cent. was not much different from the

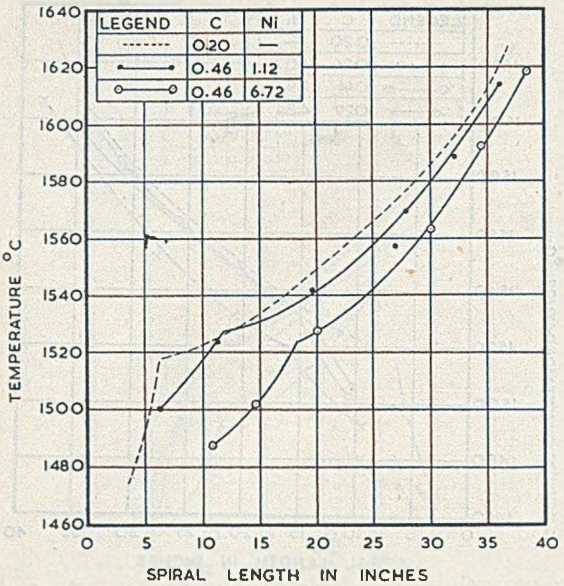


FIG. 10.—*Effect of Nickel on the Fluidity/Temperature Curves for Steel containing* 0.46 *per cent. Carbon. (A Curve for a* 0.2 *per cent. Carbon Steel is included for Comparison.)*

mean curves drawn, except for the point at only 10 deg. above the liquidus temperature. The same effect is given by the 0.39 per cent. carbon steel which had a silicon content of 0.80 per cent. The evidence tends to confirm Briggs' statement[13] that increasing the silicon content from 0.6 to 1.25 per cent. gave rise to no increase in fluidity.

Effect of Chromium

The fluidities of 0.2 per cent. carbon steels containing varying percentages of chromium were determined, and the fluidity/temperature relationships obtained are shown in Fig. 8. A reference curve of a plain 0.2 per cent. carbon steel has also been included for purposes of comparison. It will be seen that all the curves lie very close together, and that chromium increases the fluidity of a steel, especially at temperatures elow 1,560 deg. C. The break in the curve is still evident in all cases and above 1,520 deg. C. the relationship of fluidity to temperature is linear. These curves substantiate the work of Andrew, Percival, Maddocks and Bottomley,[16] who reported the fluidity of chromium steels as being practically constant for all percentages of chromium and also of Taylor, Briggs and Rominski,[13] whose curves for 2.8, 5.6 and 8.8 per cent. chromium steels were nearly identical throughout the temperature range. The latter investigators further stated that, except for a small portion of the curves at low temperatures, the curves for chromium steels were a linear function of the temperature up to 1,700 deg. C.

Effect of Nickel

The effect on the fluidity-temperature curves as a result of varying the nickel content is shown in Fig. 9, which relates to a steel containing 0.2 per cent. carbon, and Fig. 10, in which the steel contains 0.46 per cent. carbon. Referring to Fig. 9, it is seen that, above 1,530 deg. C., up to 3 per cent. nickel makes no difference to the fluidity, but that the 4.8 per cent. nickel steel has an increased fluidity at all temperatures over that of the reference 0.2 per cent. carbon steel.

Below 1,530 deg. C. the fluidity of all the nickel steels is however increased. Fig. 10 likewise shows no great difference in the fluidity of the 1.12 per cent. nickel steel from that of the reference curve, whereas the 6.72 per cent. nickel steel has an enhanced fluidity at all temperatures. There is, however, hardly any difference in the fluidity obtained between the 4.84 per cent. nickel and the 6.72 per cent. nickel steel, notwithstanding the difference in carbon content. It would appear, therefore, that the fluidity of steel, except at temperatures below 1,530 deg. C., is but little affected by the addition of up to 3 per cent. nickel. Between 3 and 5 per cent. nickel, however, an increase in fluidity is apparent but this increase is not sustained when the nickel content is increased up to 6.72 per cent. nickel.

The above does not confirm the findings of previous investigators. Andrew, Percival, Maddocks and Bottomley[16] for example reported that steels containing up to 4 per cent. nickel had a constant fluidity, the fluidity increasing, however, at higher percentages of nickel. Taylor, Briggs and Rominski,[13] on the other hand, found that nickel improved the fluidity progressively with amounts up to 3½ per cent. nickel. Higher concentrations of up to 5 per cent. nickel were found to reduce the length of flow.

Effect of Aluminium

The result obtained by the addition of 1.2 per cent. aluminium to a 0.2 per cent. carbon steel is

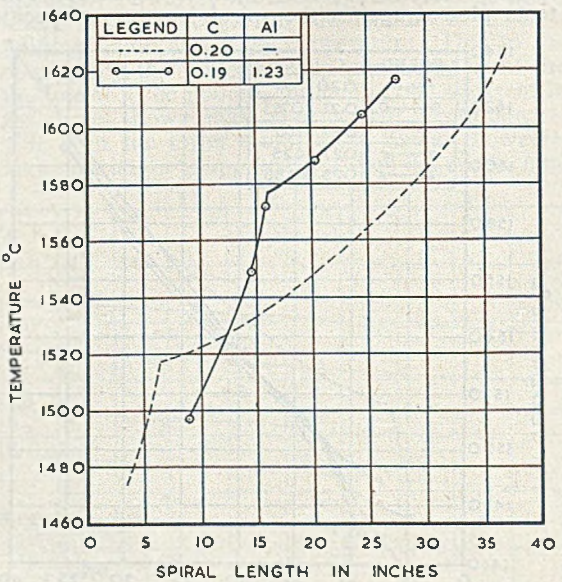


FIG. 11.—*Effect of Aluminium on the Fluidity/Temperature Curves for a* 0.2 *per cent. Carbon Steel.*

shown in Fig. 11. Above 1,530 deg. C., the fluidity of such a steel is greatly reduced, though below this temperature, the fluidity exceeds that of the plain carbon steel. The change in direction or break in the curve of this steel also occurs at a much higher temperature, namely, 1,580 deg. C. At temperatures up to 1,580 deg. C., obviously there is operating some greatly restraining influence. This appears to indicate that an aluminium-rich oxide skin on the surface of a steel does inhibit the free flow of the steel. It is well known that such aluminium-rich skins are very strong, and the fact that an aluminium steel has such a greatly reduced fluidity supports the theory that surface-oxide skins exert a dominating influence on the flow of liquid metal.

Conclusions

The rate of pouring of fluidity-test spiral moulds has been standardised and, as a result, fluidity temperature curves have been drawn which show appreciably less scatter of results than those obtained by previous investigators. Consequently, curves may be drawn which, it is claimed, give a true representation of the temperature fluidity relationship, with comparatively few spirals. An average of six or seven spirals is sufficient to obtain a trustworthy curve. As a result of reducing the scatter of results, it has been shown that all fluidity/temperature curves exhibit a break, which indicates the existence of some restraining influence operating at the lower-temperature ranges. It has been suggested that this influence may be due to the effect of surface-oxide films, which are strong enough, below a certain temperature, to prevent the free flow of the metal.

The effect of carbon, chromium, nickel and aluminium upon fluidity has been discussed in the text. The conclusions may be summarised as follows:—

1. When compared at the same temperature, an increase in the carbon content increases fluidity.

2. When compared at the same superheat, an increase in the carbon content reduces fluidity.

3. Moisture in the sand between 2 and 4 per cent. has no influence on fluidity.

4. Variations in the silicon content between 0.5 and 1.0 per cent. has little or no effect on the length of run produced.

5. An initial addition of chromium of only 0.76 per cent. increases the fluidity of a plain carbon steel in the lower temperature ranges, though further additions of chromium, even up to nearly 11 per cent., have no further effect.

6. Except at temperatures below 1,530 deg. C., the fluidity of a steel is not affected by the addition of up to 3 per cent. nickel. Between 3 and 5 per cent. nickel, however, the fluidity is enhanced, though further increases fail to maintain a corresponding increase in fluidity

7. The addition of 1.2 per cent. aluminium to a plain 0.2 per cent. carbon steel greatly reduces its fluidity and also increases the temperature at which the cusp in the curve occurs. It is thought that this fact lends support to the theory that surface-oxide films play an important part in the problem of the fluidity of steel.

Acknowledgments

The Author wishes to thank the melting sub-committee of the Steel Castings Division of the British Iron and Steel Research Association, under the chairmanship of Mr. R. Lamb, for its interest in this work and for general guidance. Thanks are also due to Mr. Protheroe, of Sheffield University, in whose department the work was performed and who has always been helpful whenever difficulties arose.

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Recent Shipbuilding Orders

Among recent shipbuilding orders announced are the following:—

WILLIAM PICKERSGILL & SONS, LIMITED, Southwick-on-Wear, Sunderland—A collier, of 5,750 tons dw, for the Société le Nickel, Paris.

A. & J. INGLIS, LIMITED, Pointhouse, Glasgow—The Crown Agents for the Colonies have placed a contract for two harbour tugs, the steam-propelling machinery for which is to be supplied by Aitchison, Blair, Limited, Clydebank.

WILLIAM DENNY & BROS., LIMITED, Dumbarton—An order for the building of two twin-screw passenger motorships, of 950 tons gross, has been received from the Turkish State Shipping Lines and Ports Administration, Istanbul.

CHARLES CONNELL & COMPANY, LIMITED, Scotstoun, Glasgow—Two motor tankers, each of about 18,000 tons dw, for Wilhelm Wilhelmsen, Oslo. They will be single-screw vessels, with six-cylinder oil engines to be constructed by Barclay, Curle & Company, Limited, Whiteinch, Glasgow.

British Standards Institution

Annual General Meeting

The annual general meeting of the British Standards Institution was held on July 11. Sir William Larke presided. The Rt. Hon. Sir John Anderson, P.C., G.C.B., F.R.S., was elected president for the coming year.

Mr. Roger Duncalfe, chairman of the general council, in presenting the annual report, explained that the work had expanded during the year in all sections, both nationally and internationally. The B.S.I. had distributed nearly three quarters of a million copies of British Standards, many of them volumes of considerable size. The B.S.I. had participated in a number of exhibitions, and the library and information service had developed substantially. He pointed out that the library now holds copies of about 43,000 oversea standards.

Mr. John Ryan, chairman of the finance committee, presented the accounts, which reflected the growth in the work, income and expenditure (£214,000) having increased by 40 per cent. over the previous year. Sir William Larke, the retiring president, in his closing address, called attention to the valuable work which the B.S.I. had done over so many years. He emphasised the need for the B.S.I. to remain an independent body, supported by all sections of industry and Government under the direct control of an elected council. Sir William dwelt on the value of standardisation to the community as a whole, and expressed the view that industry must recognise its responsibilities for maintaining this central organisation.

Tensile Testing of Metals (B.S. 18 : 1950)

This is the fourth revision of the standard which was first published in 1904. With the exception of the definition of proof stress, the standard has not been fundamentally altered. The definition of proof stress now adopted is, however, quite different from that contained in previous issues, as it has been amended to bring it in line with the practice, current in industry, of obtaining proof stress under load. The definition is amplified to indicate methods which may be used to ascertain if the material is satisfactory when the actual value of the proof stress is not required.

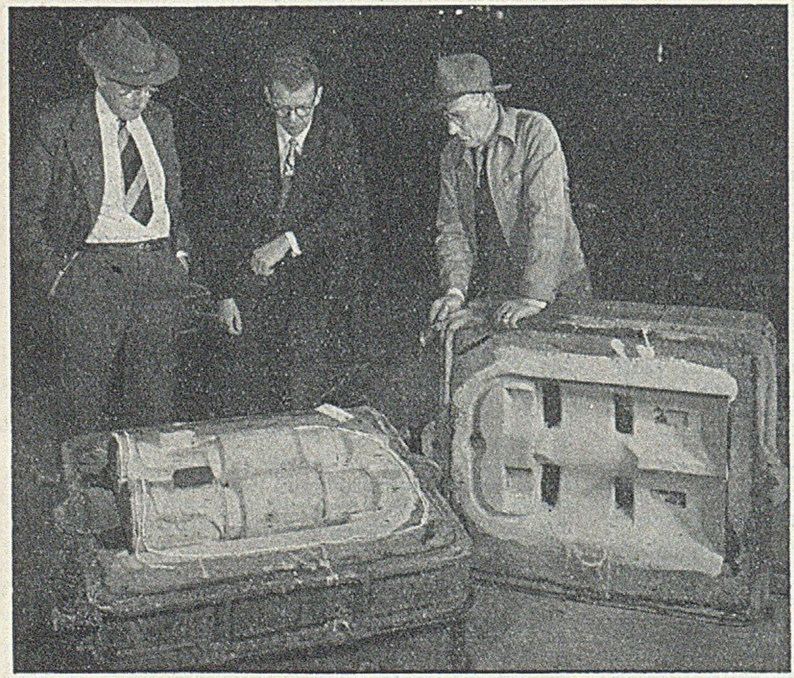
Section one of the standard contains the definitions of the principal terms relating to the tensile strength of materials. Section two sets out in detail the forms of standard tensile test-pieces for sheets, strips, sections, machined and unmachined rods and bars, and so on. It also includes the special test-pieces for cast iron, malleable cast iron, steel tubes, cylinders and wire. Section three deals with the standard methods of procedure for tensile testing, and includes guidance on the preparation of the test-pieces for testing.

Copies of this standard may be obtained from the British Standards Institution, Sales Department, 24, Victoria Street, London, S.W.1, price 2s. 6d., post free.

May Information Sheet

The May information sheet published by the British Standards Institution lists, under new standards issued, B.S. 1639:1950, Notes on the simple bend test (2s.). These notes give general information on the simple bend test, dealing with the purpose and value of the test, the influence of the geometrical proportions of the test-piece, the preparation of the test-piece, and criterion of performance and severity of test. Methods of making the test are given in an appendix. No rigid rules are laid down for bend testing.

Another new standard listed is B.S. 1651:1950, Industrial safety gloves (4s.). This covers safety gloves, mittens and hand guards made of leather, rubber, felt, polyvinyl chloride or cotton, for use in all industries. The standard specifies a range of 17 preferred types of gloves and lays down requirements for size, materials and manufacture; methods of test are included, together with recommendations on the storing of rubber gloves and on the information to be given on ordering.



Samuel Osborn & Company, Limited, well known among British steel founders, recently announced their agreement with the Ohio Steel Foundry Company, of Lima, Ohio, to acquire their full "know-how" for the manufacture of certain types of oil-refinery fittings. These fittings are used in tubular stills, and their specialised development has hitherto been mainly in American hands. The first step in exchange of information has been the visit to America of Mr. R. F. Horton, works manager of the Osborn Foundry & Engineering Company, Limited (the steel founding subsidiary of Samuel Osborn & Company, Limited), with Mr. F. Preston, machine-shop foreman. They spent six weeks in America acquiring most useful information, on the basis of which some major alterations are now being made in the layout of equipment of the Sheffield foundry. In the illustration, Mr. Horton (centre) is examining a return-bend mould at Springfield, Ohio.

Spheroidal-graphite Cast Iron*

Some Properties and Applications

By A. B. Everest, Ph.D., B.Sc., F.I.M.

(*Continued from page* 64.)

APPLICATIONS OF THE NEW IRONS

IN THIS PAPER the properties of the new spheroidal-graphite cast irons have been reviewed at length. The new irons are still in their testing period, and as already indicated, many of the current applications are exploratory in determining the full field of usefulness of the new irons. It is not intended here to catalogue a long list of present and possible future applications, but an attempt will be made briefly to indicate the fields of use of the irons as suggested by their properties.

Much has already been written on this subject† (see, for example, references numbered 6, 7, 9, 10 and 11), and further references to detailed work on particular applications are indicated below. In general, it can be stated that there is no limit to the production of the new irons. They are adaptable to all the normal forms of iron castings, and can be considered wherever such castings are desired with the improved properties indicated in the first part of this Paper.

A study of the literature shows that castings of all shapes and sizes, ranging in weight from an oz. or two up to 18 tons[6] have already been made in the U.S.A. All normal casting methods have been employed, including repetition methods, centrifugal and die casting.

The ferritising anneal is used regularly to produce castings with maximum ductility. Normally this involves only a few hours' treatment just below the critical, generally in the range 700 to 740 deg. C., to break down the pearlite. If free cementite is present, however, as perhaps in light-section castings, a preliminary treatment for some hours at 900 deg. C. is necessary to break down the primary carbides. This is followed by treatment just below the critical temperature range as described. The production of this class of casting is, therefore, subject to some limitations by practical considerations, and in particular by furnace capacity available. A point of considerable interest here is that even relatively heavy sections can readily be ferritised and this provides a means of easily meeting the demand for larger-section castings with a high degree of ductility—a class of product beyond the normal scope of malleable-iron production.

The main fields of application of the new irons can be summarised as follows:—

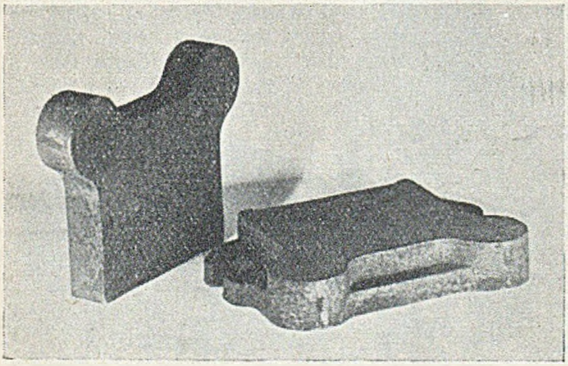
(1) Iron castings where improved toughness and shock resistance with higher strength are required—these are generally met by magnesium-treated spheroidal-graphite cast iron as cast.

(2) Iron castings in which maximum toughness, ductility and shock resistance are required—these are generally made in the irons with the ferritising anneal, although with particular compositions, the desired properties may be obtained as cast.

(3) Castings as in (1) and (2) in which reduction in section, made possible by the higher mechanical properties, leads to a saving in weight.

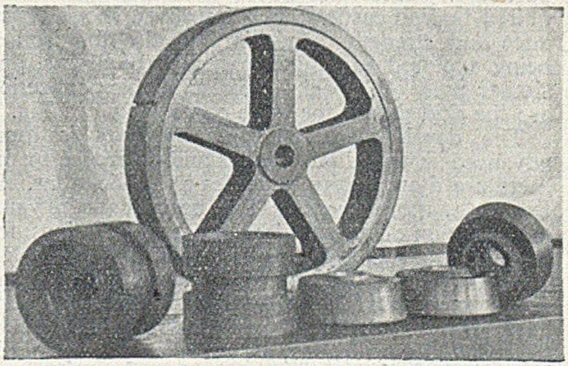
(4) Heavy-section castings, in which toughness and ductility are required, and are beyond the scope of malleable practice.

* Paper presented at the Annual Conference of the Institute of British Foundrymen. The Author is on the staff of the Mond Nickel Company, Limited, London.
† References 1 to 10 quoted with first section in last week's issue.



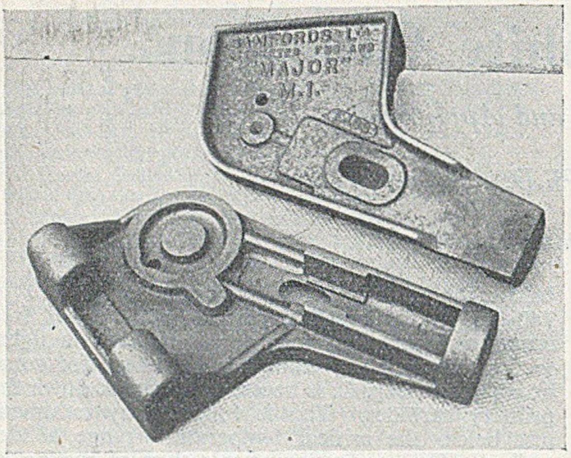
[Courtesy Sheepbridge Stokes, Limited

FIG. 8.—*Die Plates in Spheroidal-graphite Cast Iron.*



[Courtesy Ste. Griffin, Belgium

FIG. 9.—*Gear-wheel and Pinion Blanks and Brake Drum in Spheroidal-graphite Cast Iron.*



[Courtesy Lloyds (Burton), Limited, and Bamfords Limited

FIG. 10.—*Brackets for Agricultural Machinery in Annealed Spheroidal-graphite Cast Iron.*

(5) Parts, for which the properties of normal grey cast iron have been inadequate, and which were not suitable for production by the malleable process, and, consequently have had to be made in steel, but for which the properties of the new-type cast iron would be sufficient.

(6) Special-purpose irons, *e.g.*, austenitic cast irons with improved mechanical properties.

Some typical applications at present under development in Europe are shown in Figs. 1 to 11 accompanying this Paper. To date the primary interest in the new irons is for small- and medium-sized castings, particularly for the agricultural and automobile industries, and often replacing malleable or cast steel. Similar applications are being developed for details in the textile, machine-tool and general engineering industries. Typical among these applications are couplings, housings, wheel hubs, levers and link castings (all generally ferritised) for agricultural tractors and the automobile industry. Gear wheels of all types are being made in spheroidal-graphite iron as cast, and are proving particularly successful where wear resistance is required in iron castings with improved shock resistance and strength. In this field also the iron is being explored for clutch parts, brake drums, and similar uses. Of special interest in this connection are the skid guides for mine cages shown in Fig. 7.

The development of the new irons is more advanced in the United States and reference to the literature shows many examples of applications. In the U.S.A. more progress has been made towards the adoption of the new iron for heavy castings, for example, in the plant and machine tool fields. Typical applications are hammer standards and anvils and hydraulic press parts.[6] The new irons have also passed preliminary tests for castings subjected to high pressures, as, for example, hydraulic castings and compressor details.[7]

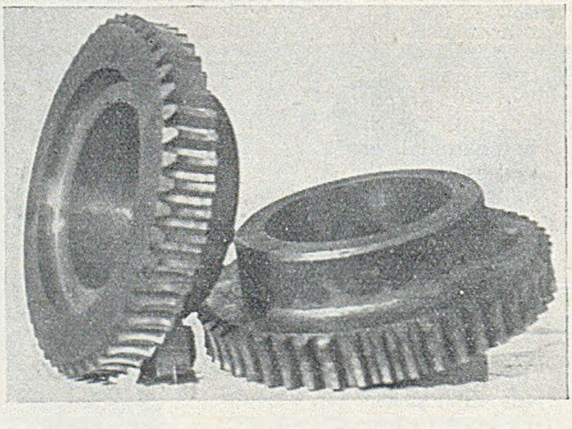
There are many applications, as, for example, in the traction field and in marine engineering where cast iron has been abandoned in the past as lacking in shock resistance. The new irons will meet requirements and enable this field to be largely restored to the iron foundries.

As indicated above, the spheroidal-graphite cast irons may be chilled. Tests have been carried out on a large scale with ploughs and other items in which shock resistance combined with wear resistance are involved. Already striking results from the use of ploughs of this type have been reported both from the U.S.A. and this country, and in this field the new iron appears to offer a quality of product which has not previously been available, that is a part with the wear resistance of chilled cast iron combined with the toughness of steel.

Crankshaft castings have received special attention, and details have recently been given by Vennerholm[10] of tests carried out by the Ford Motor Company in the U.S.A. In this case, again, considerable time must elapse before sufficient working data have been accumulated to justify a final decision, but it is interesting to note that already the results are promising and in particular show that in the pearlitic types of iron, the lubricated wear resistance is excellent.

For castings subject to heat, experience is at present limited, but points to the fact, as indicated above, that the new irons will offer distinct advantages over the conventional type from the point of view of resistance to growth and oxidation. In applications, such as brake drums, where heat checking is a common trouble, it is believed that superior results will be obtained. This view is supported by Vennerholm.[10] Applications in which the iron is at present under test in this connection include ingot moulds, die-casting dies, melting pots and glass moulds.

For chemical castings, the new iron would appear to be of particular interest. The corrosion tests reported above give an indication that under normal corrosive conditions, the new irons will be appreciably better than conventional types. That the austenitic cast irons can also be made with spheroidal graphite leads one to suppose that the resistance of irons in this class will also be substantially improved due to the more favourable



[Courtesy Ste. Griffin, Belgium.

FIG. 11.—*Machined Worm Wheels in Spheroidal-graphite Cast Iron.*

form of graphite. In many applications, the higher mechanical properties of the austenitic spheroidal-graphite irons will also be of interest.

Considerable attention has already been given to the new cast irons for the electrical field. The properties given in this Paper support the view that from the electrical and magnetic aspects, the new irons have something useful to offer to the electrical engineer, and this, coupled with the improved mechanical properties, will promote the application of the new iron, at least to the smaller sizes of motor frames and similar uses.

Kuniansky[9] has reported at length on tests carried out on centrifugally cast spheroidal-graphite pipe. The results he quotes are impressive and show that the final product is not only markedly superior in mechanical properties, but, as already mentioned, avoids the disadvantage of cast iron in shattering under high pressure—thus providing a superior type, both from the service and the transport and handling points of view.

Conclusion

In this Paper the information at present available on the properties of the spheroidal-graphite cast irons has been reviewed and an indication has been given of the applications which logically can be developed from the properties of the new materials. Interest in the new cast irons is world wide, and as their properties become better known and understood, so applications in all fields of engineering practice will be developed to the benefit of both the foundry and engineering industries.

Finally, the Author wishes to acknowledge his indebtedness to his colleagues in the Development and Research Department of The Mond Nickel Company, Limited, for their interest and assistance in preparing this Paper. In particular, he acknowledges the help obtained from the laboratory in the provision of data on the properties of the new cast irons.

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DISCUSSION

Introducing his Paper, DR. EVEREST said that much had been written on the subject of spheroidal-graphite cast iron; some Papers had dealt with the theoretical aspects of the formation of spheroidal graphite and some had discussed applications, others reviewed specific properties, but none was devoted solely to properties and applications. He hoped there was, in his Paper, a collection of material which would be really useful to the foundryman and engineer, in assessing the fields of use of this new material. The literature contained many scattered references to properties and his Paper was an attempt to collect together all the available data and to discuss it in relation to applications. He had also given new information which the engineering world was calling for—particularly with regard to electrical and magnetic properties and corrosion resistance.

There was one important point which must be realised. Spheroidal graphite was a new development in iron "as-cast," but cast iron with the conventional form of flake graphite was old and was now known in many types. Recent researches had shown that by adding magnesium (or cerium) the graphite can be changed from the flake to the spheroidal type over the whole wide range of cast irons known and a completely new series of cast irons resulted. This included irons with all the known matrix structures:—pearlitic, ferritic martensitic, acicular, austenitic, etc. The collection of data over this whole range was an immense task and the picture was still incomplete. The Paper, however, reviewed all the information now available, and referred to the present state of application of the new irons.

Terminology

DR. J. G. PEARCE, opening the discussion, said the data on corrosion resistance and on electrical and magnetic properties were both new and useful. The summary of existing information also was useful, but there was one comment he would make. It concerned nomenclature—the names they gave those things. Time, of course, would decide what terms would survive. Dr. Everest apparently used the term "spheroidal" graphite to describe nodular irons produced by the magnesium process, and further he referred to the graphite in blackheart malleable as "nodular." The point he made was that there was no distinction whatever between those particular graphite structures and they should have one name for the whole lot. The materials which the Author described had been termed "nodular" or "nodular-graphite" cast irons and those terms had been very widely accepted both in this country, the United States, and in Europe, as meaning iron having graphite in the nodular form when produced in the cast state, and so far two processes had been developed for that purpose, one using cerium and one using magnesium. When the two processes were accurately applied and within the limits which were defined for each process, they produced exactly similar graphite structures, so that they should not have different names for the same thing. The graphite nodules had spherulitic structures and those spherulites were approximately spheroidal, so that the term "spheroidal" did not specify or describe the magnesium-treated product. Furthermore the graphite in much thick-sectioned whiteheart malleable had the same spherulitic structure and was identical with that which appeared in the cerium- and magnesium-treated irons. On the basis of the graphite structure one could not differentiate the cerium-treated from the magnesium-treated nodular iron or either from an ordinary whiteheart malleable cast iron having a high sulphur content.

That was brought out in three slides which he proposed to show. One was a cerium-treated nodular cast iron, one was a magnesium-treated nodular iron and one a whiteheart malleable iron, and he invited the Author to tell them which was which.

(The three slides were then projected, one by one. Each showed a typical nodular cast-iron structure.)

Discussion—Spheroidal-graphite Cast Iron

Those, continued Dr. Pearce, represented each of the structures, and while the term " nodular " to describe graphite in malleable cast iron was to some extent established in such expressions as " temper carbon nodule," " nodule number " and " nodule count," in malleable they distinguished between the types, the aggregate type of graphite and the spherulitic type. The aggregate type occured in blackheart, which the Author called " nodular," and the spherulitic in whiteheart malleable, which he cut out of consideration altogether on the ground that the carbon was low—but that was not the case, except in very thin sections—and the carbon in such whiteheart was higher than it was in a good deal of blackheart. It could be, and had in fact, been argued by some that the graphite aggregates in blackheart malleable were not strictly speaking nodules, but that made a very fine point in the definition of the term " nodule." Nevertheless that was the material which Dr. Everest had described as nodular.

The terms " nodular graphite " and " nodular iron " were already very well established, and he therefore suggested that the term " spheroidal " offered no special advantage over nodular, and was misleading to use it as implying something different. It became still more confusing when the term " nodular " was transferred to describe malleable cast iron.

In the section headed " tensile strength," the Author said that the graphite was " incompletely spheroidised." That seemed to be an example of the misleading and incorrect use of that nomenclature. He suggested that magnesium-treated product was most easily referred to as " magnesium-treated nodular cast iron."

He also registered a strong protest at the use of the word " ferritising," which was usually unnecessary. They had terms like " annealing " or " dead annealing " in that connection which were adequate and well understood, for a very old and very long-practised process.

Finally, those interested in mechanical properties of these materials would find some new results, especially in fatigue, in a Paper issued since Dr. Everest's report was prepared. It was by Mr. J. W. Grant, and appeared in the April, 1950, issue of the B.C.I.R.A. *Journal of Research and Development.*

DR. EVEREST thanked Dr. Pearce for his comments. He did not want to spend a great deal of time then dealing with the question of terminology, and suggested it might be a suitable subject for discussion by the Technical Council under the heading of " nomenclature." If there was any implication in the Paper that he was trying to monopolise the name " spheroidal " for magnesium-treated iron, that was quite wrong.

Dr. Pearce had shown three slides. He—the Author—asserted that the graphite structure in those three slides was exactly the same, and he would not dispute the term " spherulitic " or " spheroidal " applied to any of those three. The point where he was at variance with Dr. Pearce, however, was that in his view the term " nodular " should not be applied strictly to any of them. This latter term had been used in the past to describe the aggregates of fine flakes which were a characteristic of blackheart malleable iron and the low-sulphur type of whiteheart malleable iron, and he did suggest that it was necessary to distinguish between this type of graphite and that he now termed spheroidal. The term " nodule " had slipped into those new irons, he believed, due in the first place to the occurrence of the true spheroidal type being sometimes found in whiteheart malleable.

In his view, confusion had arisen when the term nodular had been applied first to the truly spherulitic type found sometimes in whiteheart, and had then been applied to this same type when found in cerium-treated irons. Thus there were now two entirely different types of graphite called " nodular " the fine-flake aggregates and the spheroidal form. He had felt it advisable to differentiate between those two. He was prepared to admit that the last word on the nomenclature of the new irons was not yet said and the views expressed were perhaps personal to the Author. They did, however, seem logical to him.

He thanked Dr. Pearce for his contribution. Terms like " ferritising " would have to suffer a process of evolution and such guidance as the B.C.I.R.A. and the I.B.F. Technical Council could bring to bear on industrial and research laboratories in keeping their terminology correct would be very welcome.

Applications of the New Irons

MR. G. R. SHOTTON thought that Dr. Everest had done a valuable piece of work in publishing data on the various properties—he had summarised them and presented them in a comparative form.

He had one criticism to make, which he thought might be expected from him as a malleable founder. To his mind, the general trend of the Paper did show an unjustified comparison between the two materials. In Table I, for instance, in the pearlitic series, nodular types of graphite as found in pearlitic malleables were quoted as giving 30 to 50 tons tensile strength and elongation up to 5 per cent. From the lower range there would be elongation up to 12 per cent. with 30 tons, depending to some extent on the method of obtaining the pearlitic structure. The same applied to the ferritic series with a tensile of 22 to 25 tons and an elongation of 12 to 18 per cent. The present B.S.S. for grade 3 blackheart gave a 14 per cent. elongation as a minimum. In other words, it was being suggested that commercial results ranged below the present specification for grade 3.

The same criticism applied to some extent in a more general way, and he did not doubt that Dr. Everest would say he was too critical, but he felt the Paper did gloss over the question of the application of spheroidal-graphite irons. Dr. Everest had referred to the foundry difficulties and said they were outside the scope of the Paper, to which he agreed, but it did affect the application. From what he knew of the subject, he understood that foundry problems were quite serious from the point of view of shrinkage and it might restrict the scope of de-signs which could be handled commercially to obtain sound castings without undue expense.

He would also like to know from Dr. Everest as to what extent reproducible results could be obtained at present, particularly as regards the thin sections of ¼ to ½ in., as against 2 or 3 in. He had an impression that the difficulties in the lower range of wall sections were much more serious than in the thicker sections.

Dr. Everest, in reply, pointed out there was no intention of drawing invidious comparisons in the Paper. The figures quoted in Table I were taken from published information, some of which might be up to five years old or more. He understood that Mr. Shotton's remarks would be reported in full in the discussion on the Paper and he would take careful note of them. His difficulty was perhaps that to-day there were so many types of special or intermediate malleable cast irons.

With regard to the production difficulty, he had referred to a wide variety of applications, but the thing they had to remember was that the new material was only about two years old, and, as he had said in the Paper, many applications were still experimental. The average engineering designer would not change over quickly to a new untried material and, therefore, a very large number of applications on which work had been done in the development stage would still require some time before they came into general use. There were a large number of would-be applications, but this did not alter the fact that already the iron was being made on a very large scale, and he thought it fair to say that under standard conditions it was made with perfect reproducibility. The foundry difficulties to which reference had been made were the difficulties which would occur when a grey-iron foundry changed over to a material with white-iron shrinkage. Foundries used to casting grey iron might initially have difficulty in casting a white iron. There were a large number of troubles of that sort which had to be worked out, but as people became more familiar with the new metal, they would disappear.

Reference to the American literature would, he thought, convince anyone that the results were reproducible, particularly for such parts as agricultural machinery details and cast gears. Now it was becoming of more importance for heavier gears. He thought that in the next two or three years they would see a tremendous expansion in applications as difficulties are overcome and the irons become better known.

Mr. Shotton interposed to remind Dr. Everest of his question regarding difficulties or otherwise with thin sections.

Continuing, Dr. Everest said he was classing that with the general foundry difficulties regarding the new iron; chilling might occur but, if so, the castings were very easily annealed. In the United States, from work done on the spheroidal-graphite irons cast in thin sections, *e.g.*, in pipes, it was shown that, although the castings might initially be white, if they were then given a quick anneal, spheroidal-graphite resulted and the time of annealing was very short.

Founding Properties

Mr. C. A. Payne said it was probably easier to measure the engineering qualities of the new irons, but the foundry properties on which they sought information lacked a better definition and were not so readily determined. Speaking as one who had had some experimental experience of the new irons he asked if under the heading of "production properties" there were any factual data covering fluidity and the behaviour of the material relative to light castings, *e.g.*, ¼-in. thickness or so. Another point to be ventilated was the effects if any of the build-up in concentration of alloying constituents on the properties in such light sections where continuous addition and remelting was employed. Although not strictly within the subject matter of the Paper he wished to add that in this experimental experience, it was not easy to say if the fluidity was affected by slag entrapment, and the apparent need for exceedingly close limits of the effective element remaining in the metal in the case of light-iron castings.

Dr. Everest agreed with Mr. Payne's remarks about properties, but emphasised that the point he had made was that in the spheroidal-graphite irons the troubles encountered were all readily soluble. He suggested that the fact that castings such as shown in some of the pictures reproduced with the Paper, and in the American Press, were being made regularly was the answer to his point. Modifications in practice to meet the particular properties of the new irons could successfully overcome the difficulties and give them commercial castings.

A reference had been made to the entrapment of slag as upsetting the process, but already there were methods of cleaning the metal, which were practised every day, but that was getting on to the production side.

With regard to the build up of nickel, he thought it had been proved mathematically that the build-up was not so great and it was not in practice a real difficulty. The only point he made was that in the spheroidal-graphite irons the effect of nickel giving air-hardening properties would be exactly the same as in flake-graphite iron.

Corrosion Tests

Speaking with reference to Table 4, Mr. D. Marles said he did not wish to detract from the value of the results on corrosion resistance, but he thought there should be a word of warning as the results were given for a definite period of time in each particular case. Admittedly the Author had taken the precaution in one case of removing the surface film, and in the other of leaving the surface film intact in order to assess the importance of the corrosion products, but it was doubtful whether the same relative corrosion rates would have been observed for tests of longer duration. It was the results of long-term tests which were most important to the engineer. He suggested the figures were very useful, and if an engineer had a particular application it would be well worth him trying a nodular iron under actual service conditions. But from the figures he would

Discussion—Spheroidal-graphite Cast Iron

not like to guarantee that any actual service condition would be better met by a nodular iron than a flake-graphite iron. He thought that the user of cast iron would be well advised not to extrapolate the published results too confidently to normal applications.

DR. EVEREST with regard to corrosion tests said that was really a long-term matter. At least five years were required to do full tests on a new material. The tests reported in the Paper were merely an attempt to get an indication and a quick answer. The question was, was the new iron going to be better or worse than ordinary iron, and he thought he had provided sufficient data to give a first indication, though this was clearly not sufficient on which to base final applications. The indications already were that the iron would not be worse, and might even be better than the conventional types under certain conditions.

MR. D. FLEMING mentioned that he had had a slight but significant experience with corrosion in one or two fields and he would almost say categorically that no list of corrosion figures for any material was ever sufficient to proceed on for other than service trials. One could never predict the operational corrosion properties of a material from simple tabular data. The little indirect points which cropped up in service applications—minor contaminants—local aeration—impingement. etc.—always made it imperative that service trials should be made before one attempted any large-scale application. Therefore, he thought that Dr. Everest's indications were to be welcomed as giving that guide, more than could be obtained from tabular data.

DR. EVEREST agreed that every application was a case in itself, and one could not predict what was going to happen under a particular set of conditions under which the component would be operating. All one could do was to have some guidance like that given in his Paper which would help and point to what the likely results would be.

Elongation in Heavy Sections

MR. J. L. FRANCIS was glad to see that the microstructure had been mentioned in Dr. Everest's Paper. He was not concerned to discuss whether it should be termed spherulitic or nodular. Dr. Everest had given an indication, which might not be final, but it did say that at least 90 per cent. of the graphite should be in the form of nodules or spheroids to justify the claim that ductile or nodular iron had been produced. That was a rather important thing because examples might be submitted with varying amounts of graphite in nodular form, and it was valuable to have a lead as to what might reasonably be termed a successful product.

The other point he was sorry could not be discussed more fully, because it was concerned with production, was the point raised on build-up. Neither nickel nor copper was lost during re-melting, and as 1 per cent. or more of nickel or copper was introduced along with the quantity of magnesium necessary to do the work, it might become present in unwanted proportions in cases where people were making a routine product and using-up returned scrap. There was an alternative alloy available as magnesium bearing ferro-silicon with which the nodular structure could be developed successfully. Normally it carried a lower magnesium content, so a higher proportion of it would have to be used in order to obtain the necessary residual magnesium.

Another matter on which he would like to have some ruling was the question of really heavy sections—say up to 6 or 8 in. thick. Was the elongation as good in "as-cast" massive sections as could be obtained in the more usual range of up to 1 or 2 in.

DR. EVEREST replied that in the case of heavy sections no one could really know without cutting up the castings and taking out test bars. They knew that big castings had been made and every possible check test had shown that they were giving desirable properties. In the Paper he had quoted sections up to 6 in. which were referred to in the American publications, but much larger sections had been made. On page 4 of the preprint, under "Variations in Structure," he gave a reference (No. 8) which was a symposium in America, and some of the other Papers also referred to that point. From 39 to 32 tons was the range of strength in sections varying from 6 in. down to 1 in. There was in the literature a quantity of data of that type, but as for the larger sections he did not think anyone had gone to the expense of making a full examination. It was extremely difficult to take pieces out of a hammer block where the sections were up to 3 ft. thick.

With regard to nickel build-up he did not think they could discuss it there, but in practice it did not arise because, in the conditions under which the irons were made, the proportion of scrap used gave always a reasonable figure for nickel. He did not think this point was a significant deterrent to the process. In practice it was not found to arise.

MR. J. STOTT offered his own experience of cupola operation in support of Dr. Everest's statement that nickel build-up was not serious with regard to the manufacture of grey iron as had been alleged. From time to time in the foundry he had observed that after special nickel additions in the ladle the rate of "disappearance" or reduction of the nickel percentage in further melts was very quick. In practice where not more than 10 per cent. of the scrap returned for re-melt contained nickel the "disappearance" was so quick as to have negligible effects on further melts. The same applied to other alloy additions.

DR. EVEREST hoped Mr. Stott was not trying to give the impression that nickel vanished, because one of the claims well established for it was that it did not and that one could get complete recovery. He supposed what Mr. Stott meant was that it became dispersed under the particular conditions in question. The point he was trying to make was that it was a fallacy to think that, if they were making a particular alloy iron and returned part as scrap, the build-up was rapid. It built up slowly to a value which was well below the dangerous range.

MR. FLEMING pointed out that if they had 50 per cent. back scrap and added 1 per cent. nickel every time they could not reach a final 2 per cent. They would get near it, but could never reach it.

DR. EVEREST suggested that further discussion on this point would not be profitable, because it was not a property of the new iron, which was the subject under review.

Heat Transfer

MR. L. JOHNSON asked Dr. Everest if he would give his reasons for expecting the spheroidal iron to give improved heat-checking resistance over the normal flake-graphite irons. In the normal range of flake-graphite irons it was fairly well established that high-carbon coarse-flake graphite structures gave the best heat-checking resistance, and as the graphite became less and finer, the liability to heat checking normally increased. When one arrived at the spheroidal-graphite structure, the graphite was so shaped that it exerted the least effect on the properties of the matrix and, on the face of it, one would expect that the heat-checking resistance would not be very good. There was also a point with regard to welding. Surely, if the iron were welded, would there not be a likelihood of the molten metal in the weld riverting to flake-graphite iron and, if the welded part were used for a stressed application, as presumably it would be, it would thus form a weak point?

Dr. Everest said with regard to heat transfer it was an intensely complex subject, and as far as heat-checking was concerned the mechanism of it was little understood. He had quoted that the new irons did show up better from the heat-resisting point of view than did the conventional flake-graphite types, but for any particular application it was best to try it out. Generally speaking, it was thought that the new irons would be less liable to heat-cracking because the structure was free from those channels and passages caused by the long graphite flakes, along which gas penetration and oxidation could occur. There was still a good deal more work required on this subject. With regard to welding, he had said that successful welding had been carried out using ordinary arc-welding methods. The actual weld metal, that is, the filler metal, was nickel or nickel-copper, in which case, of course, the question did not arise.

DR. H. T. ANGUS pointed out that heat-checking in brake drums was only indirectly affected by graphite form. In his experience it was invariably associated with the development of surface temperatures high enough to cause the formation of martensite. Frictional heat-checking did not appear to occur without a phase change. The effect of graphite might be threefold: (1) to provide some lubrication; (2) to act as a cushion to absorb some of the stresses caused by rapid heating and cooling; and (3) to increase the thermal conductivity of the iron. The published information indicated that increasing the graphite content increased the thermal conductivity of grey iron and it appeared to be accepted that a high graphite content reduced the tendency to heat-checking, possibly by increasing the conductivity and possibly by lubrication. As so many factors were involved, however, it could not be assumed that nodular cast iron would necessarily prove more satisfactory for a brake drum than normal grey iron.

DR. EVEREST entirely agreed as to the complexity of the problem.

MR. FLEMING asked which matrix type of nodular iron was the spheroidal cast iron to which he had referred as having been applied to gear work?

DR. EVEREST said the pearlitic type was used as wear resistance was the primary requirement.

MR. FLEMING asked if he might follow that up and ask if he had any preference as to relative merits of the ferritic-type spheroidal-graphite iron as against a normal ferrite pearlite flake-graphite iron, the reasoning being that the application he had in mind would lead directly into the troubles of thin-section work which would be readily chilled. The components concerned could be annealed if trouble was experienced with white iron, but would this be better than using a normal pearlitic flake-graphite iron?

DR. EVEREST said the pearlitic was the more wear-resisting, and he thought for any particular section there would be a heat-treatment which would give the pearlitic structure in any thin sections which might be involved.

Cumulative Effect of Alloy Additions

In a written contribution to the discussion, MR. J. STOTT stated that scrap arising from specially inoculated metal should obviously be segregated for economy, but the discussion after Dr. Everest's Paper had shown that this was not always possible and that there was a fear of alloy "build-up" in the "run-of-the-shop" metal. Prompted by a remark by Mr. D. Fleming he had analysed the possibilities in the usual case of a grey-iron foundry melting an assumed steady daily quantity of "normal" scrap. It was assumed that a quantity of scrap specially enriched was also returned daily, inoculated with nickel, and evenly dispersed in the charges.

If T = Total daily melt in tons
S = Weight of nickel-enriched scrap returned
R = Weight of "normal" scrap returned
x = Percentage of nickel in scrap S (assumed constant)
N = Percentage of nickel in "normal" metal

$$\text{Let } a = \frac{S}{T} \text{ and } b = \frac{R}{T}.$$

After the first remelt the residual percentage of nickel would be:—

$$N_1 = ax.$$

After the second remelt

$$N_2 = ax + b(N_1) = ax + abx.$$

Similarly, $N_3 = ax + abx + ab^2x$,

and for n remelts we can write :—

$$N_n = ax + abx + ab^2x + \text{— —} + ab^{n-1}x$$

$$\text{or } N_n = \frac{ax(1 - b_n).}{(1 - b)}$$

As b was less than unity and n would be a large number it could be said that in time the nickel

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concentration would assume a steady maximum value (N_{max}) of

$$N_{max} = \frac{ax}{(1-b)} \quad \cdots\cdots\cdots \quad (1)$$

If the highest permissible concentration of alloy was known it would be possible to evaluate the safe maximum weight of enriched alloy that could be remelted daily from:—

$$a = \frac{N_{max}(1-b)}{x} \quad \cdots\cdots\cdots \quad (2)$$

For example, in the case of a daily melt of 20 tons and a "normal" scrap return of 4 tons daily, and an inoculation with nickel up to 2 per cent. it may be desired to limit the nickel concentration in the "run-of-the-shop" metal to 0.2 per cent. In this case:—

$$a = \frac{0.2\,(1-\frac{1}{5})}{2} = 0.08 \text{ or } 8 \text{ per cent.}$$

This would allow one to return safely up to $1\frac{3}{5}$ tons of enriched scrap without harmful effect each day.

Consideration of equations (1) and (2) showed build-up to be controllable and calculable and in no case to be feared. The same methods and equations were very useful in considering elements where there was a known loss or gain in the cupola, and in estimating the effects of daily use of "poisoned" purchased scrap containing undesirable elements, but non-segregation, though controllable, was not economical due to the steady dispersion of valuable inoculants.

Simplified Appraisal

Replying, Dr. Everest thanked Mr. Stott for his interesting written contribution on the subject of the build-up of alloys in cast iron when a fixed addition had to be made to each melt. It seemed to him, however, that it was unnecessary to go to the length of algebraic formula, since a few very simple calculations would establish the point that the build-up was limited. In this connection two simple examples could be taken.

In the first place, if one assumed that an addition of 1 per cent. of nickel had to be made to each melt, and that the melt would include 25 per cent. of its own scrap returns, then the scrap from melt one would contain 1 per cent. of nickel. With 25 per cent. scrap returns, the scrap from melt two contained 1 per cent. plus 0.25 per cent. that was 1.25 per cent. of nickel. Melt three would contain 1 per cent. plus a quarter of 1.25, namely 1.31 per cent. Similarly the fourth melt would contain 1.33 per cent. as the final nickel content, and further calculation would show that for subsequent melts this figure became stabilised, and no further appreciable build-up occurred.

In the second example one could again assume an addition of 1 per cent. of nickel to each melt, but in this case 50 per cent. of scrap returns. The second melt would contain 1.5 per cent. of nickel—the 3rd melt 1.75 per cent.—the 4th melt 1.87—the 5th 1.93—the 6th 1.96—the 7th 1.98—the 8th 1.99, and further calculation would show that the nickel content of the final metal would become stabilised at just under 2 per cent.

Dr. Everest considered that the above would make it quite clear, as pointed out by Mr. Stott, that the build-up of alloys was not a serious problem, particularly when less than 50 per cent. of scrap returns were used.

* * *

In the first section of this Paper, which appeared last week, the caption below Fig. 3 should read 3 ft. diameter instead of 3 in.

Publications Received

The Story of the Old Works, 1790-1949. By H. Field. Issued by John Harper & Company, Limited, Albion Works, Willenhall, Staffs.

The Author, using a series of quotations, draws a rather gloomy picture of the birth of Britain's industrial history. At that time most of the "masters" were ex-workmen and had "been through the mill." From general reading, the reviewer has received the impression that food was reasonably cheap and plentiful but clothes were expensive. By 1874, the men are reported to be receiving the equivalent of 100 pints of beer—and no doubt good beer—as a weekly wage, whilst to-day such an emolument would cost over £6 and they would only be receiving "austerity wallop." The amazing feature of the old works was the extraordinary number of shops. It contained no fewer than 81, the two foundries being designated numbers 65 and 74. Mr. Field writes well and has succeeded in painting a picture of the enterprise needed in the development of the old-established business. He might, however, with advantage have included a genealogical tree of the proprietors during the period under review, and, moreover, a note as to the present number of employees would have stressed the progress achieved, though the story does imply the existence of a large-scale enterprise. Readers will be fascinated at the early installation of modern plant. It is devoutly to be hoped that the frustration to be associated with modern business conditions will not prevent this honourable old firm from extending their resources to serve existing and future industrial developments. The book is nicely illustrated and provides a good half-hour's interesting reading.

The Evolution of the All-carbon Blast Furnace. By C. D. Elliot. Published for limited circulation by Carblox, Limited, c/o The Morgan Crucible Company, Limited, Battersea Church Road, London. S.W.1.

This book is based on a reprint of a Paper which the Author presented to a joint meeting of the Blast Furnace and Coke Association, in Detroit. In very readable language, the Author tells the story, starting in 1941, of the steps taken to line a blast furnace with carbon blocks. This outstanding British achievement was not brought to fruition without teething troubles. It seems that on ten furnaces there were 23 hearth breakouts between 1929 and 1943. Since using carbon blocks, the first one has still to be reported. Moreover, scaffolding is now a thing of the past, due no doubt to the non-wetting properties of carbon. The solution of the difficulties encountered was the designing of an interlocking carbon brick—now known as Carblox. The first all-carbon blast furnace was put into operation in the spring of 1949. A year is but a short time to evaluate results, but so far they are satisfactory. Because the Author is big enough to admit mistakes, the reviewer is confident that from now on straight-line progress will be registered in any process under his direction. The book runs to 40 pages and is well illustrated.

Castings for Ships and Road Vehicles

By A. G. Thomson

THE PRODUCTION of all types of marine castings in iron and non-ferrous materials and for road-vehicle engines is undertaken by John I. Thornycroft & Company, Limited, at their Woolston Works, Southampton. The foundry is the largest in south-west England and was established primarily to cater for the requirements of the company's own shipyards. Planning ahead is possible so far as castings for new construction are concerned, but there is a fair amount of repair work consisting essentially of one-off jobs, many of which have to be executed at extremely short notice and are urgently required. Also, castings are supplied to the company's associated factories at Basingstoke and Reading, where road-transport vehicles and diesel engines respectively are manufactured. In addition, castings are supplied to other firms in the vicinity of Southampton and elsewhere. This combination of jobbing for the shipyard with repetition work for the Basingstoke and Reading factories, etc., necessitates very careful organisation and the foundry is specially laid out with this dual purpose in mind. A group of finished castings is shown in Fig. 1.

The large modern pattern-shop is capable of coping with a very wide range of requirements. Since orders for marine castings are usually for small numbers, the majority of patterns are produced in wood, but a section of the shop is devoted to the production of metal patterns for repetition work. There are several pattern stores and patterns are retained in stock for as long as replacements are likely to be required. Patterns moulded in "Pattincrete" or "Hydrostone" have proved very successful and are used where they are suitable.

Metal Refining

Close control of material specifications is obtained by routine analyses of all material used in the foundries, and a special laboratory and trained staff of chemists and metallurgists are devoted to this work. A melting and refining shop for scrap deals with returns from the machine shops, consisting of gunmetal and phosphor-bronze scrap and borings, Monel metal, bearing metals, etc. The aluminium melting plant contains a ½-ton bale-out furnace made to the foundry manager's own design, and this side of the business has become so important that a new and larger melting plant has recently been erected.

The same system is adopted for ferrous scrap. Hematite is purchased as required for high-class work, but hardly any refined pig iron is bought. The phosphorus and sulphur contents of scrap iron arising in the works or purchased are adjusted by melting with a suitable proportion of steel, and the steel-mix iron is de-sulphurised with soda ash. Since carbon is picked up from the coke in the cupola, it only remains to add the right quantities of silicon and manganese for obtaining refined pig iron. Pig beds are prepared in the iron foundry by rolling a sand bed with a special roller to form the shape of the pigs. There are six beds and the boxes are so arranged that a second floor can be laid on the top. Each box holds half a ton of iron. After pouring the top row the crane lifts the boxes off and the pigs on the lower floor can be cast. Thus six tons of metal can be cast into pigs in one heat.

Internal Organisation

A very rigid system of control eliminates human error as far as possible. No melt is ever used without being analysed. Not only is every melt numbered but each one is given a symbol according to type and grade, such as A.G. (Admiralty gunmetal), V.G. (valve gunmetal), P.B. (phosphor bronze), M.B. (manganese bronze), etc.. The foundry order is provided in triplicate, showing the material, grade, symbol, pattern number, number off, description of pattern and any special properties required. Asterisks draw special attention to the ship or engine number and the delivery date. In order still further to reduce any possibility of error each different metal has a distinctly-coloured casting order sheet, such as pink for gunmetal, orange for manganese bronze, etc.

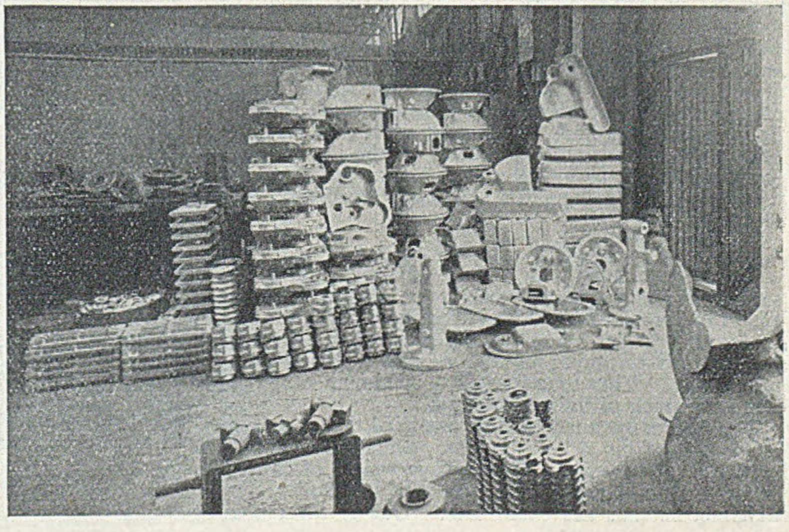


FIG. 1.—*Group of Typical Castings produced at the Thorneycroft Foundry, Southampton.*

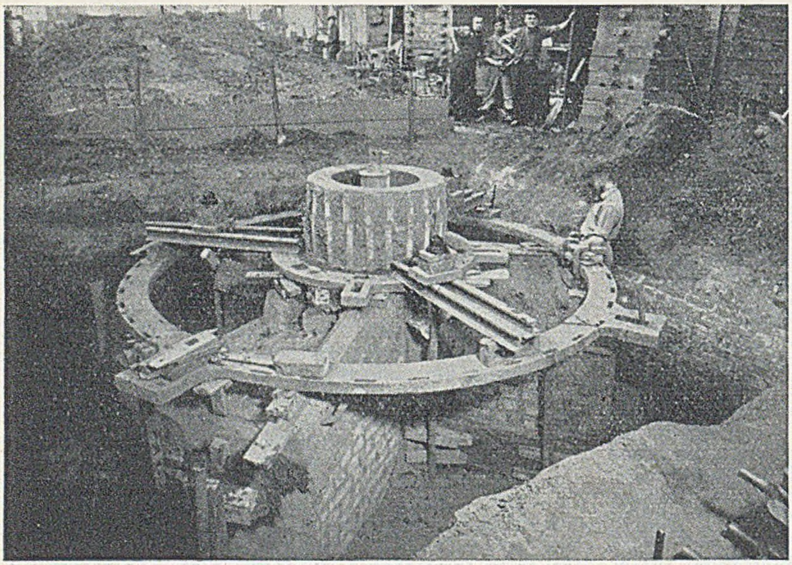


FIG. 2.—*Fastening down the Blade Portions of the Mould for the "John Biscoe" Propeller.*

When the foreman gives a job out he passes on one of the three sheets to the core-maker foreman. The moulder's name is on the sheet, so that the core-maker knows to whom the cores should be supplied. After moulding, it is the moulder's duty to mark the grade symbol on top of the mould. By inspecting the symbols on the moulds the foreman can quickly see how many boxes are ready for casting from the same metal. The foremen are instructed by the foundry manager or his assistant with regard to the melting programme, and every melt sheet has to be signed by the foreman and the storekeeper.

The furnacemen are paid according to the tonnage melted and receive an additional bonus if they exceed a certain minimum per day per furnace. When a furnace is not required for production it can be engaged in the melting of scrap, so that it is always hot and melting times are thereby reduced.

The brass foundry is capable of producing up to 15 tons of finished castings a week. Its products include propellers of all kinds up to 10-ft. dia. and 4 tons weight in manganese bronze or gunmetal, as well as flywheel housings, reverse gear casings and other engine components, or light-alloy castings. The largest moulding machine is bedded in concrete and takes boxes 52- by 64-in. Among the castings produced on this machine are pedestals for photostat machines, which are made in aluminium in one piece. For one passenger vessel, aluminium dining tables were cast in one piece ready to be screwed to the floor, and cost no more than cast-iron ones. The foundry also produces all the jigs required for the Basingstoke and Reading Works, and large jigs up to 12-ft. for flying boats have been successfully cast in aluminium.

Iron Foundry

The iron foundry is in a lofty building with a saw-tooth roof and has recently been re-painted in green and cream in accordance with the accepted modern practice of colour schemes. The melting plant comprises three balanced-blast cupolas of 10-, 4- and 2-tons capacity respectively. This foundry has a maximum output of 30 tons a week of finished castings.

The floor is spanned by four overhead cranes ranging in capacity from 25 to 3 tons. Hand-operated jibs service the heavy bay. The average weight of castings is from 3 to 4 tons, but a die for the boiler shop weighing 22 tons has been made. Due to the limited capacity of the available equipment, all three cranes serving the heavy bay had to be used in the pouring, and it was necessary for one end of the job to protrude into the adjoining bay so that a fourth crane could also be employed.

The equipment of the light bay includes a battery of seven Osborn jolt-rollover machines for repetition work. A machine for setting the blades of diaphragms has also been installed. This automatically measures the radius and spacing of the blades to a very high degree of accuracy.

Among the castings supplied to the Reading factory are manifolds. These used to be cast lying on the floor, but it has been found more satisfactory to cast them on end, so that the metal is travelling up the side of the jacket instead of coming up underneath it.

Pelleted pitch is being used in the facing sand for dry-sand work and has proved very satisfactory, since it eliminates scabs, buckles, etc., and gives a very hard mould. Oil-sand cores are used in the iron foundry as well as phenol-formaldehyde resin-bonded cores

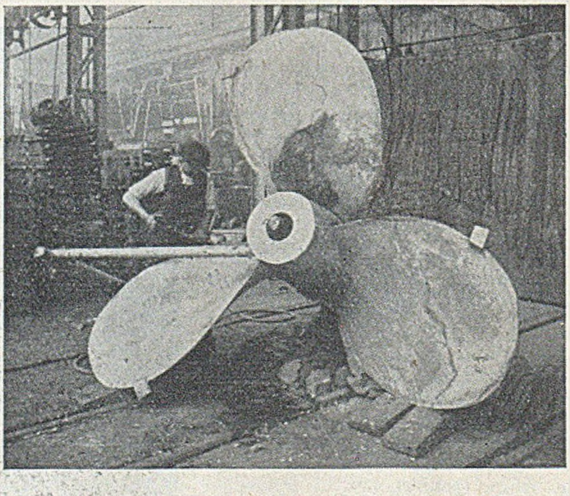


FIG. 3.—*Dressing the Bronze Propeller Casting for the "John Biscoe."*

with starch additions. Installed in the non-ferrous foundry core-shop is a "Titan" core blower capable of large output, which has proved very satisfactory on repetition work.

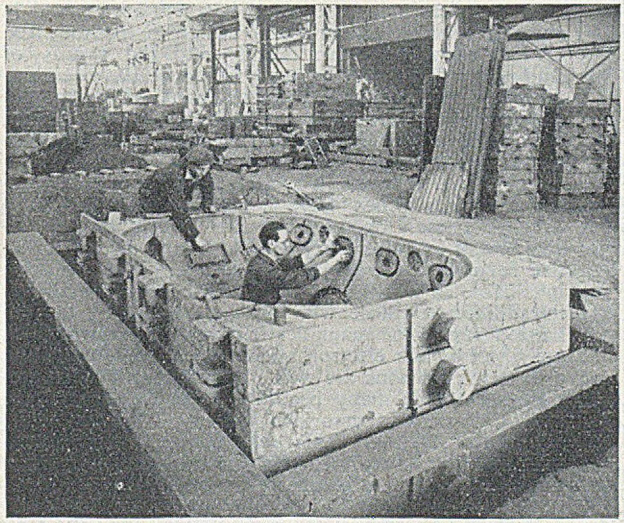
Among the responsibilities of John I. Thornycroft & Company, Limited, is the maintenance of the "Queen Mary" and the "Queen Elizabeth," and this work includes the supply of liners, valve bodies, etc. One of the most unusual orders in this connection was received when the "Queen Mary" was equipped for the transport of G.I. brides. The foundry was called upon to supply, within 24 hrs., bars and clamps of various descriptions for drying the babies' napkins.

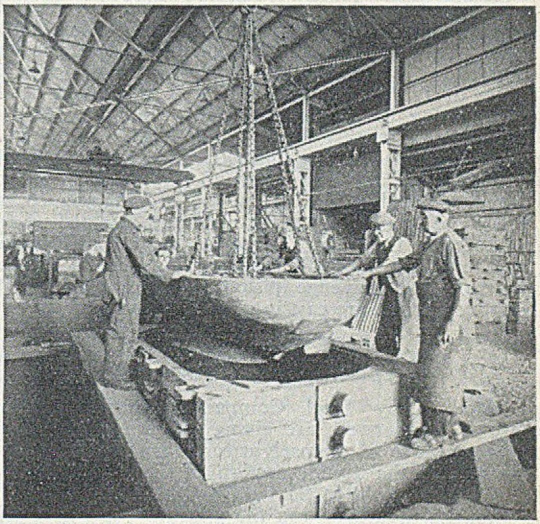
Production of Propellers

Recently, the foundry had the distinction of casting a 9 ft. 8 in. propeller in manganese bronze for the Falklands Islands Antarctic vessel, "John Biscoe." This job was a loam moulded propeller, the method of moulding being as follows:

A spindle is fitted in the centre of a loam plate. The outside ring is struck up and surrounded with sweep boards. A sweep board from an arm on the spindle sweeps down and forms the bed of the propeller. This section is put in the stove and dried. The position of the blades is then marked out in the ring. The patternmakers put on the thickness pieces which are nailed across the bed, and the spaces between are filled with sand, thus making the patterns of the blades. A dummy boss is fitted to the spindle and when this has been struck up it is put in the stove and dried. A box part is now put on the top and rammed up to make the top part of the mould. All the stiffeners and sand are removed, leaving the finished mould. The metal is run into the bottom of the boss with a large riser on the top to feed the blades. Fig. 2 shows the part finished mould and Fig. 3 the propeller in the dressing shop.

If large enough boxes are not available, propellers can be made in a sand bed. The moulder is supplied with a "carrot" and a single-bladed pattern. He rams up the bottom part of the job flat and fixes the carrot and blade in the sand. A circle is scribed by a small pin fixed in the blade. The position of the blades is then marked on the circle. The pattern is placed in position and each blade is individually moulded. After ramming up for the first blade the pattern is removed,





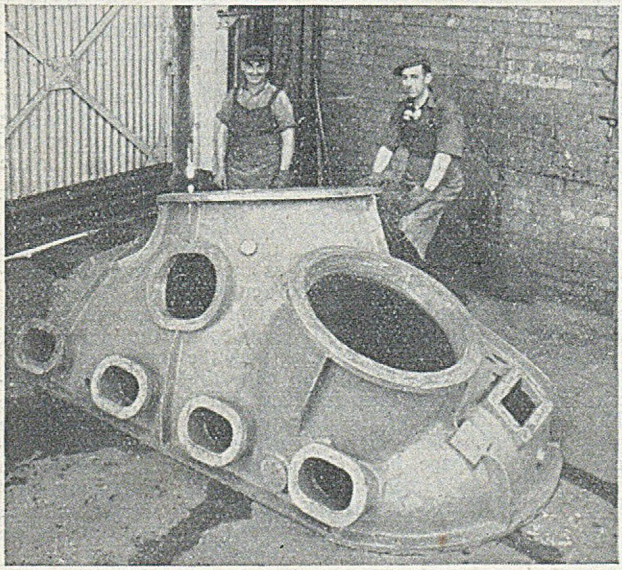


FIG. 4 (*upper left*).—*Mould for Condenser Door; putting the Side Cores in.*

FIG. 5 (*above*).—*Lowering the Core into position.*

FIG. 6 (*lower left*).—*Finished Condenser Door for a Destroyer; Cast in Gunmetal.*

Castings for Ships and Road Vehicles

the sand cut away again, and the pattern positioned for the second blade. This process is repeated until the complete propeller has been moulded.

Quantity-production propellers are made from pattern stone odd-sides, using a three-bladed metal pattern (in the case of a three-bladed propeller) from which the mould is made in the usual manner. This method is very economical for mass production. The moulding time using this procedure is reduced to about half the time required for moulding when using a single blade wooden pattern.

Propellers can also be moulded by a propeller "sweeping" machine. The method is similar to loam moulding but everything is done with metal sweeps and gauges, etc.

Large Castings for Ships

Condenser doors 8 ft. long and weighing about a ton were recently made in sand with loam cores. The mould was lined with thickness pieces and the core was made in the mould with the help of the thickness pieces. Due to the thinness of the casting it was necessary to remove the core and grids almost immediately after pouring to avoid cracking due to cooling contraction. This job was cast in gunmetal and poured at both ends. During the war, many condenser doors were made of fabricated steel, but it is interesting to find that casting in gunmetal is again being adopted for this class of work. Figs. 4 and 5 show stages in the moulding and Fig. 6 a finished condenser door casting.

Many lead and iron keels of varying sizes are produced for yachts, the largest so far weighing 10 tons. These are moulded in green sand and rammed up from a pattern in the floor. Large castings are also required for the 60-ton ships' oil engines being built at Woolston Works. The scavenge pistons weigh 2 cwts., contain eight cores, and are cast in aluminium alloy.

Apprentices' Successes

Clyde Alloy Steel Company, Limited, Craigneuk Works, Motherwell, are giving encouragement to their apprentices to fit themselves for higher posts in the industry. In the Junior section of the "John Surtees" competition, held in Scotland in the spring-time, three apprentice moulders won the prizes:—Joint first prize: John Bell and William Hunter, both of Wishaw; second prize: William Hamilton, of Lesmahagow.

It is interesting to note that the same three lads have all passed the Final examination in Foundry Practice under the City and Guilds of London Institutes, William Hamilton securing a first-class pass and the other two lads a second-class pass. All the lads are students in the foundry classes in the Burnbank School of Engineering, Lanarkshire.

SOME EIGHTY OVERSEAS STUDENTS who are spending their vacations in engineering and other works in the London area, last Friday attended a brains trust at the Federation of British Industries. Mr. Donald McCullough, public relations adviser of the F.B.I., was the question master of the brains trust, which consisted of the following: Sir F. Ewart Smith, M.I.Mech.E., technical Director of I.C.I., Limited; Mr. Kenneth Davis, director of Radiation, Limited; Captain A. M. Holbein, director of Demolition and Construction Company, Limited; and Mr. Bertram White, technical director of the F.B.I. This meeting, the first of a series to be held in London, enabled the students to receive authoritative answers to questions on the organisation of British industry.

Book Reviews

Metallurgical Applications of the Electron Microscope. Published by the Institute of Metals, 4, Grosvenor Gardens, London, S.W.1. Price 21s.

The electron microscope has now been in use for about ten years, and while the instrument possesses striking advantages in the study of forms which can be directly projected and magnified by means of a divergent beam, the application to opaque materials has required the additional technique of preparing transparent replicas of the surfaces to be examined. The scope and value of the instrument as a metallurgical tool has thus been more difficult to assess and subject to more controversy, and much further data and interpretation are still needed.

This monograph is intended to give a comprehensive and up-to-date account of the use of the electron microscope in metallurgy. It is a collection of the thirteen Papers which were presented at a symposium at the Royal Institution on November 16, 1949, with a report of the discussions occupying 25 pages. The Authors included the leading British metallurgists and other workers in this field, and also American, French and German scientists. Three of the Papers are general in character, while the remainder deal with methods and procedure, manipulative details, and the results of studies in which the electron microscope has been employed. Applications which are described include the examination of fractured surfaces, structures of iron, light metals and other non-ferrous alloys, and the form of metallic powders.

The book contains a considerable quantity of research results which have not previously been published. These, together with the descriptions of developments in present-day technique, and the authoritative reviews of the subject as a whole, make this book invaluable to workers in many branches of metallurgy in addition to those who are actually using the enhanced ranges of magnification and resolution which are given by the electron microscope. The Papers and also the discussions are well illustrated, and the reproductions of the many beautiful structures are of the usual high standard associated with the "Journal of the Institute of Metals." This book is recommended as a very useful source of new information and as a means of future reference for the majority of metallurgists.

R. G.

Hot Tinning. By W. E. Hoare, B.Sc. (Eng.). Published by the Tin Research Institute, Fraser Road, Greenford. Middlesex.

The reviewer would be interested to learn how many foundrymen know anything of the technique of tinning cast iron. Yet there are foundries which use one of the several processes available very extensively for the mass production of such articles as mincing machines. The various processes are reviewed with a wealth of technical data in Chapter 4. This chapter includes a full description of the T.R.I chloride and nitrate methods. It can be rated as the best source of information available on this particular subject. The earlier chapters cover the choice of tinning process and general theory; operations and plant; and the tinning of steel; whilst later ones deal with the tinning of copper and other metals; tinning with tin-lead alloys; treatment of tinning shop residues, and finally, notes on the determination of the thickness and continuity of tin coatings. This very interesting and technically valuable 112-page book is available to our readers on writing to Greenford—except those in Belgium and France, Holland and the U.S.A., who should write to the appropriate Tin Research Institute offices in Brussels, The Hague, and Columbus, Ohio.

News in Brief

J. Toole, Limited, are extending their premises at West End Ironworks, Oldham.

Plans have been prepared to extend the foundry premises of Richmond's Gas Stove Company, Limited, Thelwell Lane, Warrington.

The Foundry Equipment and Supplies Association announce that their telephone number has been changed from Whitehall 9801 to Abbey 7515.

An order has been made for the winding up of H. L. Cornaby, Limited, Mannerley Foundry, Ketley, Salop. The Official Receiver has been appointed as liquidator.

Having received an order for another 10 1,070-h.p. electrical locomotives, Metropolitan-Vickers Electrical Company, Limited, will soon be handling £720,000 worth of electrical equipment for Brazilian Railways.

A Rubber Research Centre has been opened on Dunlop's Malayan estates to work with the new centre at Fort Dunlop in investigating the problem of the natural rubber industry and countering competition from synthetic products.

The Traders' Road Transport Association again point out in their current monthly bulletin that, with the end of motor-fuel rationing, it is no longer necessary for operators of goods vehicles to keep records of daily mileage and fuel consumed.

Stainless-steel plaques were presented recently to 32 employees with 40 years' or more service with Samuel Fox & Company, Limited, steel manufacturers, of Stocksbridge, Sheffield. Long-service employees also received gifts of their own choosing worth £25 each.

The Essor Manufacturing Company, Limited, brassfounders, of Birmingham, recently gave a dinner to 15 workpeople who have been with the firm for 25 years or more. The fifteen, whose total years of service is 537, were all presented with cheques by the 70-year-old managing director, Mr. J. B. Perkins, who has been 54 years in the industry. The oldest recipient was Mr. S. Martin, who is 75, and has been in the industry for 59 years.

Following the announcement that two Government-owned steelmaking works, one at Monk Bridge, Leeds, and the other at Paisley, are to be closed on December 31, it is reported that at the Leeds factory, operated by the United Steel Companies, 430 workers will become redundant, and at the Paisley factory, operated by Beardmores, 540 workers will be likewise affected. The object of the long notice, said a Ministry of Supply spokesman, was to ensure that the employees would be absorbed into industry.

The E.C.A. in Paris has recently announced an agreement with the French Government whereby $965,000 of U.S. equipment is to be provided for the modernisation and development of nickel production in New Caledonia. The agreement provides for the delivery, for the U.S. stockpile, of nickel and an amount corresponding to the E.C.A. dollar advances. It is intended that the investment should increase New Caledonia nickel output from the pre-war rate of 6,000 to 7,000 tons p.a. to 10,000 to 12,000 tons p.a.

The Board of Trade announces that licences for the import of goods from the Belgo-Luxemburg Economic Union will continue to be issued on the scale which has been operating under the arrangements reached in February with the Belgian and Luxemburg authorities for the period which ended on June 30. Financial arrangements are also being continued on the present basis. These arrangements are provisional pending the settlement in O.E.E.C. of final arrangements for trade and payments in the context of the prospective European Payments Union.

Film "Bronze Founding"

The Manchester and district members of the Association of Bronze & Brass Founders, on July 11, showed the Association's film "Bronze Founding" to well over 100 boys, for whom it was mainly produced, together with teachers, youth employment officers and representatives of the industry, at the Manchester College of Technology. The Lord Mayor of Manchester, Alderman Colonel S. P. Dawson, O.B.E., M.M., T.D., J.P., who kindly introduced the film, and the audience were welcomed by Mr. G. F. Mundell, president of the Association.

The Lord Mayor said that, whilst in Manchester bronze founding might not be a major industry, it was an important activity in neighbouring areas and as Manchester did not take a narrow view of its responsibilities he was glad to have the film shown there. He said he would not attempt to influence boys in their choice of career and he was sure Mr. Mundell and the Association of Bronze & Brass Founders would not wish to influence any boy unduly, but it should be said that at present there were insufficient people in the essential work of founding.

The film "Bronze Founding," which is in colour, with a commentary by Mr. Frank Phillips, of the B.B.C., may be hired by those interested in the industry who should apply to the secretaries of the Association at 25, Bennetts Hill, Birmingham, for conditions of hiring.

Cupola Patching

Eastern Clay Products Inc., of Jackson, Ohio, U.S.A., have sent us three reprints of articles which have appeared in the American technical Press. In them, there are many references to a wet refractory mix being shot from a high-velocity gun. This method, it is claimed, reduced cupola patching costs by 50 per cent. and layers up to 10-in. thick have been applied. It is stated that patching time has been reduced to an hour. Prior to using the gun for a 60-in. cupola, no fewer than 300 bricks per day were used; now none is used. The gun is known as the "Bond-act," and its mixing device the "Bondactor." The moisture control seems to be simple for, if too much is used, the application becomes wet and runs; if too dry, dust is formed. Initially, the hard grains of ganister rebound, which provides a key for the clay. Then the grains begin to adhere to the clay to the extent of 90 per cent. The rejected 10 per cent. is collected and re-used. The dry mix consists of 40 per cent. of coarse and 40 per cent. of fine amorphous silica and 20 per cent. of pulverised clay. A 60-ft. length of hose is part of the standard equipment. It would seem that such a plant and system shows potentialities as a money saver. The cement gun has been used extensively in this country for treating boiler settings and the like, but not, so far as we know, for patching cupolas.

New Prefabricated aluminium huts will be tested at two points in Canada's far north this winter. Intended as easily constructed barracks for troops in the Arctic, the huts have been designed for economical heating at temperatures as low as −65 deg. F., and to withstand winds up to 100 miles per hour with gusts up to 125 miles per hour.

At Keighley, Yorks, on July 18, the Co-operative Wholesale Society, Limited (wringing and washing-machine manufacturing section), of Goulbourne Street, Keighley, were summoned for letting an employee, James A. Sullivan, drive an excessive period of hours. The society faced 21 summonses for permitting Sullivan to drive for more than 5½ hours continuously and for driving for more than 11 hours in 24. Fines totalling £63 were imposed.

Company News

The information under this heading has been extracted from statements circulated to shareholders, speches made at annual meetings, and other announcements.

William Baird & Company, Limited—Pointing out that there were many signs that industry as a whole was now entering on a difficult period and that foreign competition was reasserting itself, Mr. A. K. McCosh, chairman, speaking at the annual meeting, said that the country as a whole was still completely unaware of the parlous state of its economy. "It is not, however, surprising that the man in the street, in too many cases, fails to realise the position when the Government, while calling almost hysterically for greater production and more personal saving, persists with its own extravagances and maintains the many handicaps which militate against the efficient operation of industrial undertakings and are a burden on expansion and re-equipment."

Mr. McCosh said that controls were still retained long after the need for them had completely gone and thousands of people were kept employed thereby, not only on non-productive work themselves but wasting the time of many others. Excessive taxation continued seriously to deplete the resources of industry. The crowning folly, he said, was the imposition under the Town and Country Planning Act of a tax by way of a development charge whenever an expansion of more than 10 per cent. was made in the cubic contents of any works notwithstanding the fact that the ground on which the extension was to take place might have been in the company's ownership for many years and had been originally acquired with the very object of permitting of the expansion of the works in question.

Consett Iron Company, Limited—The trouble now is no longer too much money chasing too few goods, but too many planners chasing too many theories without proper consideration of even the basic factors for such planning, said Mr. Clive Cookson, chairman. He said he had little doubt that the industry would this year achieve the output "forecast" by the Government of 16.000,000 ingot tons provided the increased quantities of ore, coal, coke, and scrap could be obtained. But it was a constant struggle to provide adequate supplies especially of coking coal and coke, and, he added, there was a world shortage of ore.

Yet it was not so long ago that some public men and economic planners, in their attempts to build up any sort of case for nationalisation, criticised the industry for not planning to reach "the ridiculous figure of 20 and even 26 million tons annually" by 1953.

Lancashire Dynamo & Crypto, Limited—The directors are asking the consent of the Capital Issues Committee to the issue of 83,476 ordinary shares of £1 each at the price of 80s. per share. This offer is being made to holders of ordinary stock or shares registered on July 14, in the ratio of one new share to every £6 of ordinary stock or six ordinary shares.

Geo. Adlam & Sons, Limited—Mr. S. H. Gillett, chairman, stated at the annual meeting that the time is fast approaching when the directors will have to submit proposals for raising more permanent finance than bank accommodation.

Associated British Engineering, Limited:—At an extra-ordinary general meeting to follow the annual meeting on July 31, capital bonus resolutions will be proposed. The issue will capitalise £50,000 for 200,000 5s. shares in the proportion of one for every four 5s. units held on August 15.

Obituary

MR. WILLIAM WILSON, of John Rutherford & Sons, Limited, agricultural engineers, of Coldstream (Berwickshire), died suddenly last Saturday. He was 68.

MR. PETER SHEARER NEWLANDS, a former director of Alex. Newlands & Sons, Limited, agricultural engineers, of Linlithgow, died on July 10 at the age of 72.

MR. ALEXANDER MCAUSLAND KENNEDY, managing director of the former Northumberland Shipbuilding Company, Limited, Howdon-on-Tyne, died recently at the age of 60.

MISS FLORENCE KELLETT, a director of W. Kellett & Company, Limited, engineers and non-ferrous founders of Attercliffe Road, Sheffield, 9, for the past 15 years, died recently after falling from a train. Miss Kellett was 74.

MR. G. H. BUTLER, a former secretary of Naylor, Benzon & Company, Limited, iron, steel, metal, and ore merchants and exporters, of Gracechurch Street, London, E.C.3, died recently. Mr. Butler represented the company on the Baltic Exchange from 1919 until his appointment as secretary in 1937, which position he held until he retired in 1943.

MR. LESLIE SKINNER, head of the former shipbuilding firm of Wood, Skinner & Company, Limited, Bill Quay, Gateshead, which ceased operations many years ago, died recently at the age of 84. He made the firm into a limited company in 1897 and extended it to meet wartime needs in the 1914-18 war. The yard was closed in 1925, and sold in 1939.

Wills

LEIGHTON, WILLIAM, scrap-iron merchant, of Moxley, Wednesbury (Staffs)	£1,203
HARRISON, R. C., founder of R. C. Harrison & Sons (Brassfounders), Limited, of Leicester	£25,161
MILNER, J. E., founder and head of John E. Milner & Sons, ironfounders, of Holmfirth (Yorks) ...	£14,327
WALKER, SIR ALEXANDER, a director of Glenfield & Kennedy, Limited, hydraulic engineers, of Kilmarnock	£521,204
BARRACLOUGH, MISS ANNIE MARTHA, a director of William Barraclough, Limited, ironfounders and kitchen range manufacturers, of Stanningley...	£96,352
STREET, H. C., managing director of Vivian, Younger & Bond, Limited, metal merchants, etc., of Basinghall Street, London, E.C.2, and a member of the committee of the London Metal Exchange	£25,171
WINDELER, G. E. C., of Rhodes & Windeler, consulting engineers, of Manchester, formerly for 25 years chief engineer with Mirrlees, Bickerton & Day, Limited, Diesel-engine manufacturers, of Stockport	£14,051
MCGILL, H. A. H., a director of Textile Machinery Makers, Limited, and managing director of Platt Bros. (Sales), Limited, Oldham, chairman of Adolphus Sington & Company, Limited, Manchester	£73,168
JONES, CHARLES, late a director of the Gwersyllt Silica Brick Company, Limited, manager of the Abenbury Brick Works, Wrexham, and general manager and secretary to the Bwlchgwyn Silica Company, Limited, near Wrexham	£7,547
BARKER, J. H., a director of John Shaw & Sons, Wolverhampton, Limited, the British Tool & Engineering Company, Limited, and Jenks Bros., Limited, engineers, toolmakers, etc., of Wolverhampton, and formerly a director and general manager of Greenwood & Batley, Limited, Leeds	£9,623

THE AUTUMN MEETING of the Institute of Metals will be held in Bournemouth from September 18 to 22.

THE TELEVISION PROGRAMME on August 2 will include a feature "Some Modern Application of Photography," when details will be shown of the work being undertaken at the Kodak factory at Harrow.

THE INSTITUTE OF PHYSICS, at their annual general meeting on July 20, elected Professor W. E. Curtis (professor of physics, King's College, University of Durham, Newcastle-upon-Tyne) as president.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FOUNDRY PIG IRON
Stanton Machine-cast Pig Irons are clean-melting, and economical in cupola fuel.
All types of castings are covered by the Stanton brands of pig iron, including gas and electric fires, stoves, radiators, baths, pipes, and enamelled products generally; repetition castings requiring a free-running iron, builders' hardware and other thin castings.
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Stanton Foundry Pig Iron in all grades is also available in sand cast form.
We welcome enquiries on foundry problems and offer free technical advice.
PROMPT DELIVERY FROM STOCK
THE STANTON IRONWORKS COMPANY LIMITED - NEAR NOTTINGHAM

Company Results

(Figures for previous year in brackets.)

BLAW KNOX—Interim dividend of 10% (same).

G. HOPKINS & SONS—Interim dividend of 7½% (6%).

TROJAN (HOLDINGS)—Interim dividend of 5% (nil).

BEANS INDUSTRIES—Interim dividend of 10% (same).

NORTON INDUSTRIES—Interim dividend of 7½% (same).

INBUCON—Final dividend of 13% (10%), making 15% (12%).

SWAN, HUNTER & WIGHAM RICHARDSON—Interim dividend of 4% (same).

TELEGRAPH CONSTRUCTION & MAINTENANCE COMPANY—Interim dividend of 5% (same on smaller capital).

MASON & BURNS—Net profit to March 31, £11,816 (£12,959); adjustment tax reserve, £646 (£407); dividend of 10% and bonus of 10% (same); forward, £22,208 (£15,246).

BRITON FERRY STEEL COMPANY—Trading profits to April 2, £218,194 (£236,351); net profit, £37,679 (£46,815); dividend of 15% (same); forward, £90,958 (£90,050).

BROMILOW & EDWARDS—Net profit to March 31, £10,454 (£16,818); reserves not required, nil (£8,305); to general reserve, nil (£16,500); dividend and bonus of 12½% (same); forward, £6,196 (£3,304).

HAMMOND LANE FOUNDRY COMPANY—Net profit for 15 months to March 31, £17,484 (£13,519 for year 1948); dividend of 2½%, making 15% for 15 months (12½% for year); to reserves, £2,312; forward, £9,092 (£7,978).

GREENWOOD & BATLEY—Trading profit for the year to March 31, £156,977 (£123,035); balance, £63,962 (£44,261); to reserve, £20,000 (£10,000); final dividend of 10%, making 15% (same); forward, £83,931 (£72,577).

HARTLEY & SUGDEN—Balance on trading for the year ended April 30, £52,195 (£34,185); net profit, £17,331 (£11,137); over-provision for taxation, nil (£2,294); to general reserve, £10,000 (same); dividend of 10% (8½%); forward, £5,982 (£2,369).

TRIPLEX FOUNDRY—Balance from trading account for the year ended March 31, £25,851 (£33,160); balance, £13,864 (£20,437); to income tax, nil (£8,250); taxation equalisation reserve, £5,000 (nil); dividend of 7½% (10%); forward, £18,791 (£18,383).

HOBBS, HART & COMPANY—Net profit to March 31, £21,604 (£16,499); to income tax, £8,157 (£6,104); profits tax, £3,150 (£2,273); provision for renovation of Cheapside premises, £1,500 (nil); dividend of 6% (same) and bonus of 2% (nil); to general reserve, £5,000 (£5,750); forward, £1,525 (£863).

A.B.C. COUPLER & ENGINEERING COMPANY—Consolidated trading profit to September 30, 1949, subject to adjustments of certain selling prices, £107,204 (£51,097); balance, £34,484 (£13,618); estimated surplus on amounts set aside for taxation, £2,285 (£3,508); to general reserves, £26,133 (£10,856); dividend of 15% on doubled capital (20% on smaller capital); forward, £24,767 (£18,737).

KITCHEN & WADE—Consolidated trading balance to March 31, £139,289 (£129,066); balance, £117,228 (£110,042); to further amount off new plant and vehicles, £10,095 (nil); taxation, £70,843 (£75,365); off new issue expenses, £1,720 nil); general reserve, £10,000 (same); second interim dividend of 12½% (same), making 25% (same), but on larger capital; forward, £16,515 (£14,633).

HACKBRIDGE & HEWITTIC ELECTRIC COMPANY—Group trading profits to March 31, £339,848 (£200,955); group net profit, £135,016 (£74,310); profit retained by subsidiary, £13,803 (nil); net profit of company, £121,213 (£74,310); to directors' pensions, £5,000 (same); general reserve, £57,500 (£30,000); dividend of 15% on increased capital (12½%); forward, £37,491 (£27,728).

NEWMAN, HENDER & COMPANY—Consolidated trading surplus to April 1, £121,895 (£102,807); net profit, £47,557 (£38,101); final ordinary dividend of 7½% (same), making 12½% (same), the interim dividend of 5% for 1948-49 being paid on smaller capital; to preference dividends, £5,445 (£2,726); reserve against possible fall in stock values, nil (£20,000); forward, £72,020 (£45,062).

MOUNTSTUART DRY DOCKS—Profit of group, plus income from trade investments, for the year ended March 31, £185,637 (£623,424); net profit, £81,614 (£295,520); over-provided for taxation, £15,000; to general reserve, £25,000 (£220,000); staff pensions reserve, £15,000 (£55,000); preferred ordinary dividend, £8,465 (same); deferred ordinary dividend of 10⅔% (same); forward, £263,294 (£238,041).

ROTHERHAM FORGE & ROLLING MILLS COMPANY—Trading profit with sundry revenue for the year to March 31, £134,883 (£168,016); balance, £58,326 (£69,669); final dividend of 10%, making 15% on increased capital (same on smaller capital); to development reserve, £15,000 (£40,000); general reserve, £15,000 (£10,000); dividend equalisation reserve, £10,000 (same); pension fund, £1,588 (nil); forward, £19,000 (£16,455).

JOHN BROWN & COMPANY—Group balance from trading account for the year ended March 31, £2,829,727 (£1,965,816); the 1949 figure includes a transfer of £250,000 from general reserve; profits and receipts relating to preceding years, £507,732 (£295,931); group net profit, £1,337,827 (£988,388); transfer to capital reserve, being pre-acquisition profits, £2,660 (nil); final dividend of 9½%, making 12½%, tax free (same); attributable to outside holders, £236,286 (£379,466); forward, £2,581,714 (£1,855,230).

New Patents

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." The Specifications are open for inspection at the Patent Office, 25, Southampton Buildings, London, W.C.2. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

631,945 SEAILLES, J. C. Manufacturing cast iron.

632,060 THIEMANN, W. H. A. (Oesterreichischamerikanische Magnesit Akt.-Ges.). Regenerative furnaces.

632,064 FOX & COMPANY, LIMITED, S., and BAGNALL, F. T. Manufacture of steel.

632,104 STANTON IRONWORKS COMPANY, LIMITED, and WILSON, P. H. Continuous production of hollow bodies by the centrifugal process.

632,130 SUMMERS & SONS, LIMITED, J., and JONES, J. F. R. Furnaces for the heat-treatment of materials.

632,406 STEIN & ATKINSON, LIMITED, and FOWLER, E. F. Heat-treatment furnaces.

632,445 MOND NICKEL COMPANY, LIMITED. Nickel-alloy castings.

632,471 WRIGHT, F. V. Strip rolling mills.

632,712 MOND NICKEL COMPANY, LIMITED (International Nickel Company, Inc.). Heat-resisting alloys and articles made from them.

632,734 MIDLAND TAR DISTILLERS, LIMITED, and DAVIES, E. B. Casting of metals.

632,852 METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, and CHISHOLM, A. W. J. Measurement of surface roughness.

632,882 WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY. Magnetic alloys and methods of producing thin sheets thereof.

632,931 PHILIPS LAMPS, LIMITED. Coated welding rods.

632,958 SOC. ANON. DES ACIERIES CI-DEVANT G. FISCHER. Method and device for filling annealing pots.

632,991 INTERNATIONAL COMBUSTION, LIMITED, POOLE, F., and BAWDEN, E. Electric welding.

633,034 WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, and WORNE, S. Tilting furnaces and metal mixers.

633,049 FORD MOTOR COMPANY, LIMITED. Foundry core-box vents.

633,122 MOORE, W. E. Top-charged electric furnace.

633,217 SKODA WORKS, PLZEN. Heavy-duty cupola furnace.

633,224 STEIN & ATKINSON, LIMITED, and ASHLEY, J. P. Heat-treatment furnaces.

633,232 HAMILTON, W. B. Production of alloys of iron, nickel and chromium.

633,310 JOHNSON, MATTHEY & COMPANY, LIMITED, and CHASTON, J. C. Alloy.

633,311 PHILIPS ELECTRICAL, LIMITED. High-frequency electric furnaces.

633,319 WILD-BARFIELD ELECTRIC FURNACES, LIMITED, and ELLIS, C. C. Furnace and other doors.

633,374 TAUB, J. Interconnecting concrete-reinforcing iron or steel bars.

633,538 MALLORY METALLURGICAL PRODUCTS, LIMITED, and TUCKER, N. A. Resistance welding apparatus.

633,833 SHEPHERD, G. R. (Westinghouse Electric International Company). Heat-resistant alloys.

633,836 ABBEY, A. (Miles, J. C.). Hot-air furnaces.

633,946 HOCKING, L. N. Casting of metals and alloys.

New Trade Marks

The following applications to register trade marks appear in the "Trade Marks Journal":—

"POLYGRAM"—Metal foundry patterns and metal castings. POLYGRAM FOUNDRIES, LIMITED, Power Road, Gunnersbury, London, W.4.

"CEMP"—Steel moulds. CONCRETE EQUIPMENT & METAL PRODUCTS (WESTMINSTER), LIMITED, 5, Queen Anne's Gate, Westminster, London, S.W.1.

"NELWELD"—Electric welding apparatus. TED NELSON, c/o Heron, Rogers & Company, Bridge House, 181, Queen Victoria Street, London, E.C.4.

"BIRLOY"—Unwrought and partly-wrought heat-resisting metals and alloys. BIRLEC, LIMITED, Birlec Works, Tyburn Road, Erdington, Birmingham, 24.

"BLUECOAT" AND SCHOOLBOY DEVICE—Copper and zinc sheets. ENFIELD ROLLING MILLS, LIMITED, Millmarsh Lane, Brimsdown, Enfield (Middx).

SEAGULL (DEVICE)—Heating, cooking and sanitary appliances. COAST BUILDERS' MERCHANTS, LIMITED, 55, Front Street, Monkseaton, Whitley Bay (Northumberland).

"TANTCHLOR"—Unwrought or partly wrought metals and their alloys. LENNOX FOUNDRY COMPANY, LIMITED, Tantiron Foundry, Glenville Grove, New Cross, London, S.E.8.

Raw Material Markets

Iron and Steel

Apart from the low- and medium-phosphorus pig-iron and the Derbyshire grade of high-phosphorus iron, makers are able to satisfy all demands made upon them. Hematite, refined irons, and the Northamptonshire high-phosphorus irons are all in good supply, and foundries requiring these grades can usually obtain requirements up to their licensed tonnages.

A steady flow of orders from the motor and allied trades enables the engineering foundries to obtain good outputs. These demands, supplemented by the needs of other trades, ensure maximum outputs for many months ahead. The position of the light and jobbing foundries, however, shows little improvement, new business being scarce.

Foundry coke supplies are meeting current requirements, but some foundries are unable to build up stocks. Ganister, limestone, and ferro-alloys are being supplied to requirements, while firebricks can be obtained to specification.

The heavy re-rollers are not fully employed, there being little demand for the sections and bars rolled by them owing to existing stocks at consuming points. The light mills, however, are well employed on the smallest sections and bars, many of these mills being able to work their full quota of shifts. The sheet re-rollers are obtaining maximum outputs, which fall short of the demands made upon them, and they are unable to cope with the additional business offering from both home and oversea consumers. The strip mills are also busy, particularly for the narrower gauges.

Steelworks have no difficulty in disposing of their outputs of sheet bars, but little pressure is forthcoming for billets, blooms, etc., apart from special quality steels and the small square and flat billets.

The heavy rolling mills continue to work to capacity and they can only accept fresh business for forward delivery, except in exceptional cases where tonnage is needed to make up rolling quantities. Plates—both light and heavy—are in particularly heavy request, and there is no sign of any slackening in the demand for black and galvanised sheets.

Non-ferrous Metals

The only change in the controlled prices of metals last week came by way of an adjustment in the premiums for high-grade zinc, which have been for a very long time on the low side and unrealistic in comparison with premiums charged in the U.S.A. and other countries. Nevertheless, the adjustments deemed necessary by the Ministry of Supply are decidedly drastic compared with the premiums ruling before, and it will take consumers a little while to get accustomed to them.

Tin continues to occupy the centre of the stage, for daily price fluctuations have been very wide. Last week's turnover was considerable, but below that of the previous week, when hectic buying from the United States and the Continent raised interest to a high pitch. Nevertheless, it would be wrong to suppose that all the steam has gone out of the tin market. This is certainly not the case, and one section of market opinion holds the view that we may see a strong rally which will raise the quotation perhaps as high as £750.

Metal Exchange official tin quotations were as follow: *Cash*—Thursday, £677 10s. to £678; Friday, £685 to £685 10s.; Monday, £699 15s. to £700; Tuesday, £708 10s. to £709; Wednesday, £729 10s. to £730.

Three Months—Thursday, £678 to £678 10s.; Friday, £684 15s. to £685 5s.; Monday, £699 10s. to £700; Tuesday, £707 10s. to £708 10s.; Wednesday, £729 to £729 10s.

Business in scrap metals has been on a quieter scale, mainly on account of the approaching holiday season, and we must expect for a few weeks that dealing will be rather slow. For the moment, at any rate, prices are steady and largely unchanged.

New Catalogues

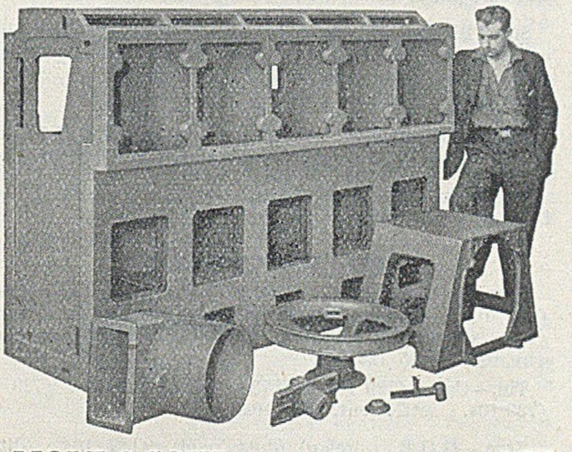
Foundry Plant. Three leaflets have reached us from Modern Furnaces & Stoves, Limited, of Booth Street, Handsworth, Birmingham, 24. They are numbered 19, 20 and 22. The first illustrates and describes a gas-fired portable mould dryer available in two sizes. Both are designed to give 30,000 cub. ft. per hr., but one at a temperature of 250 deg. C. and the other at 400 deg. C. The illustrations show its use in mechanised production. No. 20 describes and illustrates a type of gas burner of novel design, whilst No. 22 treats of a gas-fired cabinet type of core stove. The one illustrated takes 40 core plates 18 in. or a lesser number of larger sizes. It is thermostatically controlled to give working temperatures ranging between 100 and 250 deg. C. and a special feature is the inclusion of a flame-failure safety device. There is also a picture of five-chambered gas-fired batch-type stove, each compartment being capable of individual temperature control. The leaflets, which have been carried out in a pleasing uniform white and blue design, are available to our readers on writing to Birmingham.

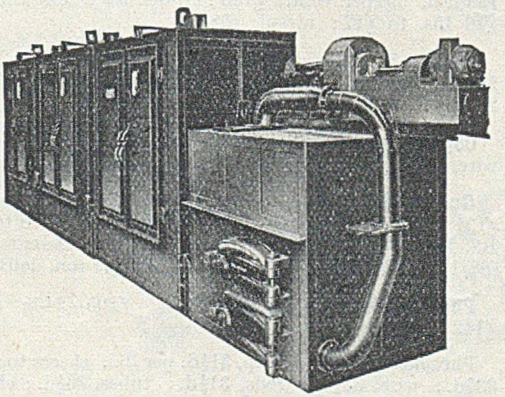
Iron and Steel Castings. We much appreciate receiving from the Hunt Spiller Manufacturing Corporation, 383, Dorchester Avenue, South Boston 27, Mass., U.S.A., their latest bulletin on modern metallurgy. It is not only this country which can boast of venerable progressive concerns, for the Hunt Spiller firm was born in 1810. The brochure opens with a historical *cum* who's who section. The fundamental practice for cast iron in these works is to melt in the cupola and refine in an air furnace. It will be gathered from this fact that the foundry specialised in high-grade—often alloyed—cast iron and references are made, *inter alia*, to Ni-Resist and Ni-Hard. An interesting feature of this foundry is that it uses 400 tons of Westonite sands daily. The brochure is nicely illustrated and succeeds in its efforts to convince buyers that the foundries are well placed to supply high-grade production.

Metallic Salts. A leaflet received from Murex, Limited, Rainham, Essex, lists the salts, oxides and acids of molybdenum, tungsten and vanadium which they manufacture. It is available to our readers on application to Rainham.

Universities and Industry

A party of teachers from Oxford, Cambridge and Sheffield Universities was recently entertained by the United Steel Companies, Limited. Three days were spent in visiting steelworks in Sheffield and Scunthorpe and in discussions with the company's staff. The idea of trying this experiment came from the F.B.I. conference on relations between industry and the universities which was held last November at Ashorne Hill. Discussions ranged over a wide field and included the company's organisation which was explained by the managing director Mr. Gerald Steel, development and investment policy, research, the training policy of the company and opportunities for arts graduates in the steel industry. Mr. A. J. Peech, the deputy managing director, led a discussion of problems affecting the steel industry as a whole, including the location of plants and the comparative efficiency of the British, Continental and American steel industries.





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

(Delivered, unless otherwise stated)

July 26, 1950

PIG-IRON

Foundry Iron.—No. 3 Iron, Class 2 :—Middlesbrough, £10 10s. 3d. ; Birmingham, £10 5s. 6d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent P, £12 1s. 6d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si)—North Zone, £12 10s. ; South Zone, £12 12s. 6d.

Scotch Iron.—No. 3 foundry, £12 0s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £13 2s. 6d. ; South Zone, £13 5s.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £13 12s. 6d. ; South Zone, £13 15s.

Cold Blast.—South Staffs, £16 3s. 3d.

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, £12 0s. 6d. ; Scotland, £12 7s. ; Sheffield, £12 15s. 6d. ; Birmingham, £13 2s. ; Wales (Welsh iron), £12 0s. 6d.

Spiegeleisen.—20 per cent. Mn, £17 16s.

Basic Pig-iron.—£10 11s. 6d., all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.)

Ferro-silicon (6-ton lots).—45 per cent., £33 15s. ; 75 per cent., £49.

Ferro-vanadium.—35/60 per cent., 15s. per lb. of V.

Ferro-molybdenum.—70/75 per cent., carbon-free, 8s. 6d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £109 per ton.

Ferro-tungsten.—80/85 per cent., 8s. 9d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 9s. 9d. per lb. of W.

Ferro-chrome.—4/8 per cent. C, £60 ; max. 2 per cent. C, 1s. 5½d. lb. ; max. 1 per cent. C, 1s. 6d. lb. ; max. 0.15 per cent. C, 1s. 6¾d. lb. ; max. 0.10 per cent. C, 1s. 7d. lb.

Cobalt.—98/99 per cent., 13s. 6d. per lb.

Metallic Chromium.—98/99 per cent., 5s. 3d. per lb.

Ferro-manganese (blast-furnace). — 78 per cent. £28 3s. 3d.

Metallic Manganese.—96/98 per cent., carbon-free, 1s. 7d. per lb.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—Basic : Soft, u.t., £16 16s. 6d. ; tested, up to 0.25 per cent. C (100-ton lots), £17 1s. 6d. ; hard (0.42 to 0.60 per cent. C), £18 16s. 6d. ; silico-manganese, £23 19s. ; free-cutting, £20 1s. 6d. Siemens Martin Acid : Up to 0.25 per cent. C, £22 4s. ; case-hardening, £23 1s. 6d. ; silico-manganese, £26 6s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £19 16s. 6d. ; basic, hard, over 0.41 up to 0.60 per cent. C, £21 1s. 6d. ; acid, up to 0.25 per cent. C, £23 1s. 6d.

Sheet and Tinplate Bars.—£16 16s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £20 14s. 6d. ; boiler plates (N.-E. Coast), £22 2s. ; chequer plates (N.-E. Coast), £22 19s. 6d. ; heavy joists, sections, and bars (angle basis), N.-E. Coast, £19 13s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £22 6s. ; flats, 5 in. wide and under, £22 6s. ; rails, heavy, f.o.t., £19 2s. 6d. ; hoop and strip, £23 1s. ; black sheets, 17/20 g., £28 16s.

Alloy Steel Bars.—1-in. dia. and up : Nickel, £37 7s. 3d ; nickel-chrome, £55 ; nickel-chrome-molybdenum, £61 13s.

Tinplates.—I.C. cokes, 20 × 14, per box, 41s. 9d., f.o.t. makers' works.

NON-FERROUS METALS

Copper.—Electrolytic, £186 ; high-grade fire-refined, £185 10s. ; fire-refined of not less than 99.7 per cent., £185 ; ditto, 99.2 per cent., £184 10s. ; black hot-rolled wire rods, £195 12s. 6d.

Tin.—Cash, £729 10s. to £730 ; three months, £729 to £729 10s. ; settlement, £729 10s.

Zinc.—G.O.B. (foreign) (duty paid), £127 10s. ; ditto (domestic), £127 10s. ; "Prime Western," £127 10s. ; electrolytic, £132 ; not less than 99.99 per cent., £138.

Lead.—Good soft pig-lead (foreign) (duty paid), £96 ; ditto (Empire and domestic), £96 ; "English," £97 10s.

Zinc Sheets, etc.—Sheets, 10g. and thicker, all English destinations, £146 5s. ; rolled zinc (boiler plates), all English destinations, £144 5s. ; zinc oxide (Red Seal), d/d buyers' premises, £119.

Other Metals.—Aluminium, ingots, £112 ; antimony, English, 99 per cent., £150 ; quicksilver, ex warehouse, £16 15s. to £17 ; nickel, £386.

Brass.—Solid-drawn tubes, 19¾d. per lb. ; rods, drawn, 25½d. ; sheets to 10 w.g., 24d. ; wire, 24½d. ; rolled metal, 22¾d.

Copper Tubes, etc.—Solid-drawn tubes, 21½d. per lb. ; wire, 209s. per cwt. basis ; 20 s.w.g., 217s. 9d. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £131 to £138 ; BS. 1400—LG3—1 (86/7/5/2), £140 to £145 ; BS. 1400—G1—1 (88/10/2), £186 to £244 ; Admiralty GM (88/10/2), virgin quality, £192 to £239, per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £205-£245 ; L.P.Bl, £142-£156 per ton.

Phosphor Bronze.—Strip, 31½d. per lb. ; sheets to 10 w.g., 33¾d. ; wire, 33½d. ; rods, 31½d. ; tubes, 36½d. ; chill cast bars : solids, 31½d., cored, 32½d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Ingots for raising, 2s. 2d. per lb. (7%) to 3s. 1½d. (30%) ; rolled metal, 3 in. to 9 in. wide × .056, 2s. 8d. (7%) to 3s. 7½d. (30%) ; to 12 in. wide, × .056, 2s. 8½d. to 3s. 7½d. ; to 25 in. wide × .056, 2s. 10½d. to 3s. 9½d. Spoon and fork metal, unsheared, 2s. 5d. to 3s. 4½d. Wire, 10g., in coils, 3s. 1½d. (10%) to 4s. 0¾d. ; (30%). Special quality turning rod, 10%, 3s. 0½d. ; 15%, 3s. 5½d. ; 18%, 3s. 9¾d.

Personal

MR. PETER ROY, chief buyer of Smith & Wellstood, Limited, ironfounders, Bonnybridge, has retired after over 46 years' service with the firm. He was presented with a pair of binoculars and sum of money.

MR. D. G. DENOON, joint publicity manager of British Insulated Callender's Cables, Limited, has been elected chairman of the British Electrical and Allied Manufacturers' Association publicity committee.

MISS H. M. DOLMAN, who acted for Peat, Marwick, Mitchell & Company as secretary of the Foundry Trades Equipment and Supplies Association, is leaving to take up the position of secretary to the British Hydromechanical Research Association, Harlow New Town, Essex.

MR. J. J. PEARCE, of Lincoln College, Oxford, and formerly of King Edward's School, Birmingham, 22-year-old son of Dr. J. G. Pearce, O.B.E., has been awarded a United States Government scholarship for study in the U.S. during the next academic year. After a period at Yale University, he will continue at the Wharton School of Finance and Commerce of the University of Pennsylvania, Philadelphia.

Changes of Name

The undermentioned companies have recently changed their names. The new titles are given in parentheses.

C. G. MORTON, LIMITED, steel and iron manufacturers and merchants, etc., of Sheffield (W. & J. Landerson, Limited).

G.M.U.C., LIMITED, Wolverhampton (General Metal Utilisation Company, Limited).

G. B. TUSTIN, LIMITED, engineers, iron and steel workers, etc., of Handsworth, Birmingham, 19 (Union Engineering Company (Birmingham), Limited).

Board Changes

IMPERIAL SMELTING CORPORATION, LIMITED—Mr. Alfred Baer has been elected a director.

FAIRFIELD SHIPBUILDING & ENGINEERING COMPANY, LIMITED, Glasgow—Mr. Jackson Millar has been appointed a director.

STURTEVANT ENGINEERING COMPANY, LIMITED—Mr. W. N. Goodman has resigned from the board on account of ill-health.

JOHN BROWN & COMPANY, LIMITED—Sir Frank H. Nixon has resigned his directorship. He joined the board in January, 1946.

DOULTON & COMPANY, LIMITED—Mr. L. J. E. Hooper, chairman and joint managing director, has resigned his position as joint managing director, but will retain his office as chairman. The board has appointed Mr. E. Basil Green to be managing director.

MONSANTO CHEMICALS (AUSTRALIA), LIMITED—Mr. T. G. Crane has been appointed deputy managing director. He joined Monsanto Chemicals, Limited, London, nearly 18 years ago as an assistant plant chemist in the rubber chemicals section of the Ruabon works. For some time past he has been manager of the technical sales department.

British Association of Chemists

The London section of the British Association of Chemists is to visit Chamonix, Mont Blanc, Haute Savoie, France, during the summer. The party will leave London on July 30, returning to London on August 14. While it may be possible to arrange a visit of technical interest, the visit is intended as an opportunity for members and their friends to spend their holidays together, and not with a technical object.

CLASSIFIED ADVERTISEMENTS

SITUATIONS WANTED

FOUNDRY FOREMAN (37, seeks position. Fully experienced hand and mechanical production, core shop, cupola, etc. Excellent references.—Box 772, FOUNDRY TRADE JOURNAL.

FOUNDRY METALLURGIST.—Experienced in alloy and high duty irons, cupola, crucible, and oil fired rotary furnaces, and foundry management. Desires position with grey iron foundry.—Box 722, FOUNDRY TRADE JOURNAL.

METALLURGIST, with University Degree and extensive practical iron and steel foundry experience, requires position, preferably in London area. Age 39.—Box 700, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

A VACANCY has occurred in a large old-established Midlands firm for a Senior Metallurgical Chemist, preferably of degree standard, who would be able to take charge of a small foundry control laboratory, and at the same time deal oftentimes on his own with the many and varied metallurgical (ferrous and non-ferrous) problems which arise from day to day in the factory. The position is permanent and pensionable.—Applications marked T.R.19, giving age, experience, and salary required, should be addressed to Box 792, FOUNDRY TRADE JOURNAL.

A VACANCY has arisen for a CHIEF PROCESS LAYOUT ENGINEER, in a South Wales light engineering factory. Applicants must have served a recognised apprenticeship in mechanical engineering, have been educated up to Ordinary National Certificate standard, and have had at least 5 years' experience in layout work. Housing accommodation will be made available. Salary in accordance with age and qualifications.—Apply Box 668, FOUNDRY TRADE JOURNAL.

BENCH MOULDER.—Jobbing iron. Must be first-class man, good wages and production bonus. Ground floor flat available. West Country.—Box 714, FOUNDRY TRADE JOURNAL.

CHIEF METALLURGIST required for Steel Foundry in Sheffield district. Must have experience in control of Arc Furnace melting of carbon and alloy steels, physical testing, heat treatment, pyrometry. Age 30-40. University graduate preferred.—Apply, stating age and qualifications, to Box 776, FOUNDRY TRADE JOURNAL.

DIE DESIGNER. First-class man, experienced in design of gravity dies for aluminium castings. Must be fully aware of modern mechanical methods, estimation, design and construction. Excellent remuneration.—Apply A. R. FORD, Vowles Aluminium Foundry Co., Ltd., Bank Street, West Bromwich, Staffs.

FOREMAN MOULDER, Greensand, for iron foundry, East Scotland, engineering jobbing work. Accustomed to supervise up to 20 skilled men on piecework. Modern building and good staff conditions.—Box 796, FOUNDRY TRADE JOURNAL.

FOUNDRY SALESMAN DIRECTOR.—One with good connections for aluminium, iron and non-ferrous. Small modern progressive foundry.—Box 790, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—Contd.

APPLICATIONS are invited by an old-established West of England Engineering Firm for the post of FOUNDRY MANAGER. Applicants should be reasonably young, have received sound practical foundry training, up-to-date Metallurgical knowledge, and fully capable of supervising the layout and operation of a new jobbing foundry producing 20 tons of grey iron castings weekly.—Apply Box 710, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN.—A really first-class, reliable, experienced and energetic man not under 38 years of age, required for modern foundry producing 40 tons per week, engineering and high class machine tool castings in green, dry sand and loam. It is essential that applicants produce evidence of successfully filling a similar position. Good house, adequate salary and pension scheme.—Applications, which will be treated as strictly confidential, should state full particulars of training, positions held, to Box 800, FOUNDRY TRADE JOURNAL.

FOUNDRY MANAGER.—Leading steel foundry in the North West, manufacturing castings up to 15 tons each in weight, requires experienced Foundry Manager to take full charge of steel foundries.—Applications, giving full experience, training, and salary required, should be sent to Box 804, FOUNDRY TRADE JOURNAL.

METALLURGIST required for laboratory attached to non-ferrous foundries in the London area. Applicants with experience in copper base materials will be preferred. Salary in accordance with qualifications and experience.—Write, giving full particulars, to Box 798, FOUNDRY TRADE JOURNAL.

PRODUCTION CONTROL SUPERVISOR.—Heavy engineering company in the North West requires first class Production Control Executive. Full knowledge of modern methods is required and a record of successful application. Good salary with prospects and superannuation scheme in a first class company is available.—Please reply, stating qualifications, experience, salaries earned, and salary required, to Box 806, FOUNDRY TRADE JOURNAL.

PRODUCTION SUPERINTENDENT.—First class Engineer and Works Manager is required by an important company in the North West, manufacturing steel castings up to 15 tons and a full range of gears to the largest sizes. The basic requisites are full and effective practical knowledge of steel founding of large castings, works management, and knowledge of operation of heavy machine tools. The post is superannuable, and particulars of career, experience, salaries earned, and salary required, should be sent to Box 802. FOUNDRY TRADE JOURNAL.

SENIOR RESEARCH METALLURGIST required (aged 30-40 years), to take charge of laboratory research and library services, reporting to the Chief Metallurgist. Applicants should be graduates or holding equivalent professional qualifications, with industrial experience covering ferrous and, preferably, non-ferrous metals, and a knowledge of radiography would be an advantage.—Write, giving full knowledge of education, experience (in chronological order) and salary required, marking the application "Confidential" to CHIEF PERSONNEL SUPERINTENDENT, David Brown Foundries Co., Ltd., Penistone Sheffield.

SITUATIONS VACANT—Contd.

TECHNICAL REPRESENTATIVE required by leading manufacturers of Foundry Equipment for the areas Scotland, N. E. England and South. Applicants, preferably those residing in these areas, must have a good personality, a good working knowledge of modern foundry practice, and the technical ability to discuss schemes and problems with prospective customers.—Apply Box 780, FOUNDRY TRADE JOURNAL.

WANTED, Wolverhampton district, ASSISTANT FOREMAN, for Engineers' Non-ferrous Foundry.—Apply Box 740, FOUNDRY TRADE JOURNAL.

WANTED, Wolverhampton district, skilled WOOD PATTERN MAKER, also a JUNIOR METAL PATTERN MAKER.—Apply Box 742, FOUNDRY TRADE JOURNAL.

FOUNDRY WANTED

WANTED.—Foundry within 25 miles radius of Birmingham, or controlling interest in same. Considerable business can be introduced.—Details to Box 768, FOUNDRY TRADE JOURNAL.

FOUNDRY FOR SALE

IRON Foundry for Sale, including plant and equipment. Unrestricted freehold premises, building 53 ft. by 67 ft., standing on about ½ acre of ground, 36 miles from London. All material allocations. Electric light, power and water. Output 20 tons monthly, capable of development.—Apply Box 784, FOUNDRY TRADE JOURNAL.

MACHINERY WANTED

URGENTLY WANTED.—All types of Foundry Plant, including Sand Mills, Cupolas, Blowing Fans, Hand and Pneumatic Moulding Machines, Sand Mixers.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.,
Crosswells Engineering Works, Langley Green, near Birmingham. Broadwell 1359

WANTED

MODERN FOUNDRY PLANT, of all descriptions. WE WILL PAY CASH.

FRANK SALT & CO., LTD.,
Station Road, Blackheath, Birmingham.
BLA. 1635.

WANTED

CUPOLAS of all sizes, also Cupolettes; cash waiting.

FRANK SALT & CO., LTD.,
Station Road, Blackheath, Birmingham.
BLA. 1635.

MACHINERY WANTED

1. 2-TON O.E.T. CRANE, double girder type with 2-ton electric hoist block; pendant controls, span approx. 36 ft.
2. 4 to 6 ft RADIAL DRILL. No. 4 or 5 Morse taper bore in spindle.
3. 5 to 10-cwt. FOUNDRY SAND MIXER.

GLYN ENGINEERING WORKS LTD.,
Lower Race, Pontypool, Mon.