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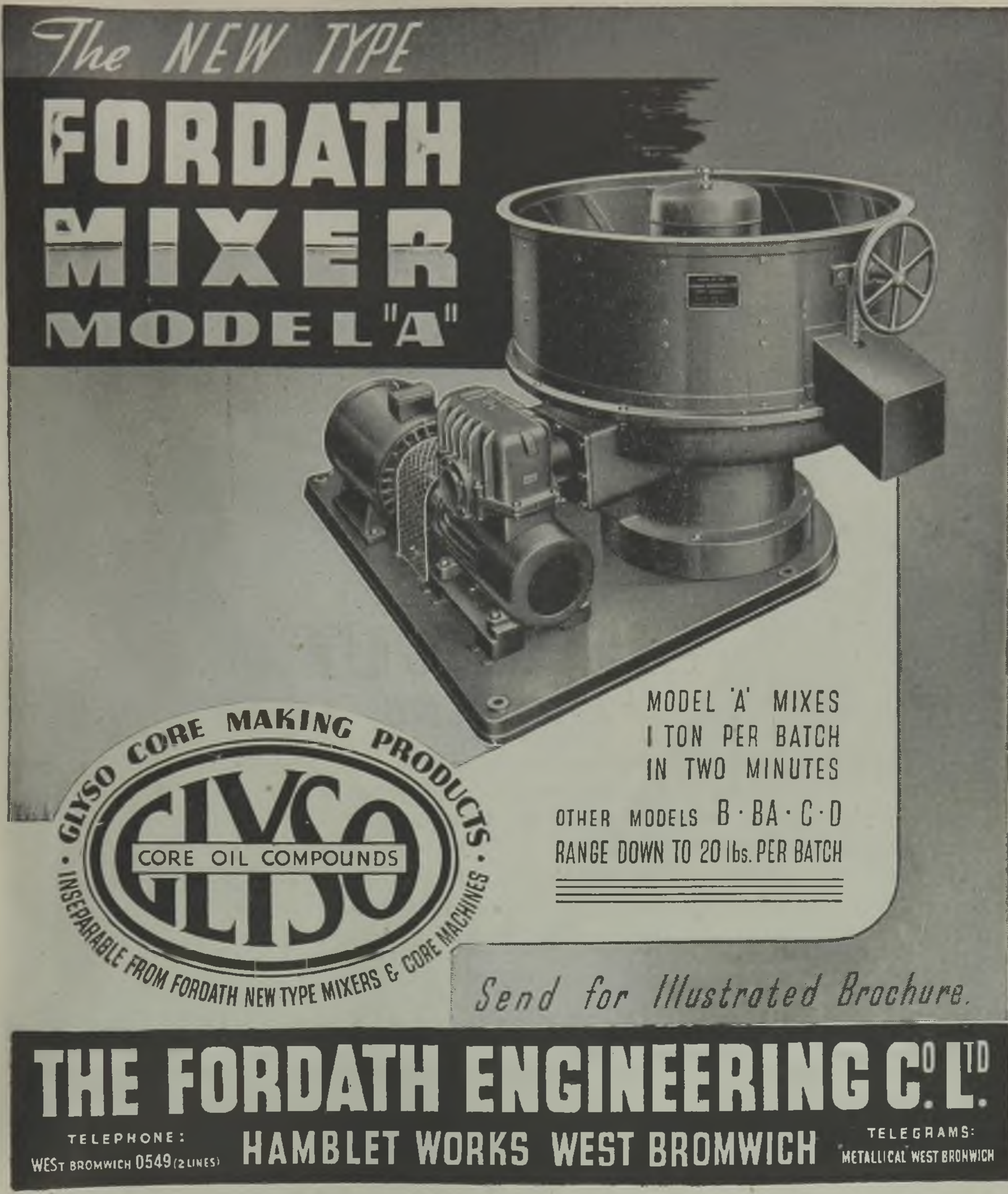
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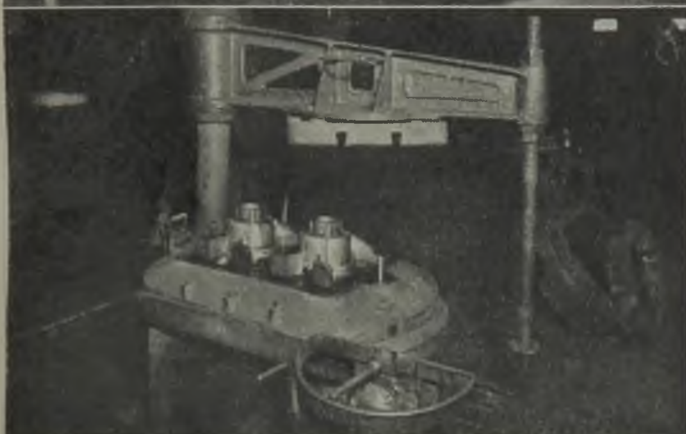

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In Search of the "Know-why"

The ironfoundry industry is banking to a very large extent on expanding or at least maintaining its post-war business by the popularisation of high-duty iron. Wonderful progress has been made during the war in providing industry with a wide range of alloys exhibiting properties which qualify them for use in entirely new spheres. By meticulous care in raw material selection, controlled melting and moulding practice, quite a large number of concerns are well placed to meet the specifications built up around the new products. They have confidence in their ability to "deliver the goods," but are they quite as knowledgeable as to how it all happens? There have been from time to time a number of comfortable theories which fit in quite nicely with practice until some new line of experiments finds a new one, which fashion then favours for a time. According to Gillet, inherent properties, now eliminated or in process of elimination in the metallurgy of steel, are still a factor in the production of cast iron owing to the relatively small quantities handled and the limited chemical reactions to be associated with normal cupola practice. Heredity is largely but not entirely neutralised by silicon-bearing ladle additions.

It is around this aspect of cast-iron metallurgy where speculative theory has see-sawed for the last two decades. Piwowarski and Norbury first supported a graphite nuclei theory, and later discarded it. In 1941 it was revived by Massari and Lindsay. Eash has a theory that silicon additions to molten cast iron provide local concentrations which precipitate kish and thereby inoculate. Then there was another theory which postulated that suspended silica slime seeded out on cooling primary graphite and effected inoculation. Not altogether a new theory, for it was first propounded in 1929 by Boegehold, is the influence of nascent hydrogen consequent upon a high humidity blast blown into both blast furnace and cupola. Gillet attaches some real importance to this particular aspect, and since he spoke there has appeared a further research of a supporting character. This was undertaken by Dr. A. W. Schneble, Jnr., and Prof. John Chipman. The experimental work was based on melting in an induction furnace using a vacuum or controlled atmosphere. Moreover, casting was effected without changing the conditions.

The most interesting statement was that by "superheating in moist hydrogen, nitrogen or carbon monoxide produces marked effects which depend on time and temperature of superheating." The data are interpreted as showing that superheating effects are not to be attributed to the destruction of residual nuclei. Results are also out of harmony with theories of nucleation by non-metallic particles. It is concluded that the presence of carbon monoxide is the chief factor operating to produce the effects of superheating. It is postulated that this gas acts as a graphitiser during solidification, and that the principal effect of hydrogen is that of a carbide stabiliser or carbon monoxide remover. When this research came up for discussion, there were many compliments for the excellence of the experiments undertaken, but few for the carbon-monoxide theory. A number are still protagonists of either nuclei destruction by superheating, seeding by inoculation, and seeding consequent upon silicon concentration of inoculants. This completes the circle, and it is high time that this interesting problem was retackled by British research workers. British foundry executives, like the Americans, certainly possess the "know-how" on the production of high-duty cast iron, but apparently both nations lack the "know-why."

Contents

S.A. MEEHANITE CONFERENCE

The fourth annual research conference of the Meehanite Metal Research and Development Association of Southern Africa was held at Johannesburg on September 14 and 15 last. Approximately 30 members attended the two-day meeting, from all parts of the Union and Rhodesia.

A dozen or so Papers were introduced and discussed at the technical meeting on the first day, under the chairmanship of Mr. A. G. L. Lewis. A management meeting, under the chairmanship of Mr. D. Lion-Cachet, was held on the second day and included seven more Papers.

At the Association luncheon the guest speaker was Mr. Wm. A. Gibson, consulting engineer, of Australia, who was spending a few days in the Union on his return from the United States, Mexico, Brazil, and the Argentine. Mr. Gibson made some interesting comparisons of foundry and economic conditions in Australia and the countries he had visited. Australia, he stated, was so heavily taxed that the maximum ceiling on incomes was between £1,300 and £1,400. The cost of living was rather more favourable than in South Africa. This drastic taxation had the effect of limiting initiative. The effects had not yet been felt throughout industry, but were becoming apparent.

Among the only favourable consequences was the tendency for responsibility in the higher positions to be shared. Australia had a basic wage for every worker, male or female, over 21, to which was added a margin for the skill accorded to the industry, which for moulding was about £2 a week. Moulders earned about £6 17s. for a week of 44 hrs. In making comparisons it was necessary to allow for the difference in value of the Australian pound. Australian foundries were not yet down to actual production, in the full sense of the word.

Comparing foundry conditions in various countries, Mr. Gibson said that for foundries of equal size, Australian and South African foundries were ahead of the average American foundries he had seen, the reason being that America was mainly concerned with production work, which was on such a general scale that the methods of the smaller jobbing foundry were not given corresponding attention.

A SERVICE TO THE SERVICES

No doubt many employees of large firms have on their shelves at home books which they would gladly give up for a really good cause. Appeals have been issued by the Prime Minister, Air Chief Marshal Tedder, Field Marshal Montgomery, and General Alexander, and all testify to the great need and value of books for the Forces. Employers will be rendering an invaluable "Service to the Services" by having copies made of Mr. Churchill's appeal and posting them in suitable places in their premises.

Copies may be obtained from the Department of Salvage and Recovery, Ministry of Supply, Berkeley Court, Glentworth Street, London, N.W.1.

COLOUR IN THE HOME

The British Colour Council has issued a folder entitled "Colour in the Home," containing a booklet showing colour schemes (in paint) suitable for use in interiors of small houses, together with swatches giving larger patterns of the colours, and introductory notes. Paint will probably be one of the first commodities to be released in large quantities, and this folder, while not intended as a permanent work of reference (as will be the case with the Council's dictionary of colour for interior decoration, now about to be printed), will be extremely useful as a guide for reconstruction and redecoration as well as in the temporary building which will take place in the post-war period.

The price of the folder, which is obtainable from 28, Sackville Street, London, W.1, is 6s. per copy.

COMPETITIVE TIDINESS

A Canadian society, the Industrial Accident Prevention Association, has suggested that the following rating values can usefully be used in organising inter-departmental competitions in large works:—

Condition of floors and stairs	15
Condition of equipment (including radiators, lights, piping, etc.)	35
Condition of stock and supplies	30
Collection and removal of scrap	5
Condition of window ledges, partitions, etc. ...	10
Clean and clear gangways	5
	100

PUBLICATION RECEIVED

Studies in Nutrition for Industrial Caterers. Compiled and issued by Barkers (Contractors), Limited, 25, Denmark Street, London, W.C.2.

If the object of this brochure is to make employers realise that the canteen deserves at its head a well-trained official just as much as the works, then it has ample justification, but it contains no information that the trained canteen manageress is not likely to know already, or does not know, where to find it in standard works of reference.

CATALOGUE RECEIVED

Stainless and Heat-resisting Steels. Samuel Fox & Company, Limited, Stocksbridge, Sheffield, have just reissued a revised brochure covering the physical properties of a range of stainless steels, and have produced a companion book dealing similarly with heat-resisting steels. It is to be regretted that in both cases information as to the properties of these steels as castings is completely ignored, except for a statement: "Other forms Castings, Forgings." Both brochures are exceptionally well presented, and at least equal pre-war productions.

SPEED OF ROTATION IN THE CENTRIFUGAL CASTING PROCESS

By Dr. J. E. HURST

Discussion on a Paper presented at the Annual Conference of the Institute of British Foundrymen. Mr. J. W. Gardom occupied the chair. Dr. Hurst's Paper was printed in our issues of October 5 and 12.

Mr. T. R. Twigger (Member) expressed thanks to Dr. Hurst for having amassed in one Paper a very great deal of known information and views on speeds of rotation of centrifugal machines. No doubt those who had occasion to use centrifugal casting machines would refer to it again and again in the future. Commenting that no reference was made in the Paper to the effect of speed on factors such as soundness, Mr. Twigger said one would imagine, for example, that the speed of rotation might have a serious influence on the amount of gas occluded in the molten metal. Since one of the peculiar faults liable to occur in centrifugal castings in metal moulds was pin-holing, one could imagine that the mould speed might have a close connection with ultimate soundness in that respect. He also asked for information on how the densening effect of the centrifugal force on the molten metal affected the mechanical properties, for the information available so far was very meagre. Another problem was the possibility of hot tears occurring due to the mould spinning at high speed when the casting was in a white hot condition. Mr. Twigger said he had helped to make many thousands of centrifugal castings in high duty cast iron, but he did not think hot tears of the kind described had occurred in any of them. Nevertheless, it would be interesting to have positive information on the point, in respect of either cast iron or steel.

Influence of Vibration

Mr. A. E. Peace (Member) recalled that in the early days of centrifugal casting, or rather when it was being commercialised in this country, one heard much as to its value in the direction of improving mechanical properties, and that improvement was ascribed to the elimination of segregation, and the increase of density. Therefore he wondered whether by raising the speed of rotation and increasing the centrifugal force an even better result could be achieved. Further, no matter how good one's machinery might be, some degree of vibration was to be expected. Such vibration had been found to produce banded segregation. Therefore, he asked, what steps were taken to reduce or control vibration and whether in a particular machine an optimum speed might be used because of its effect on reduction of vibration?

Mr. E. Longden, M.I.Mech.E. (Member) mentioned a Paper he had submitted to the French Convention some time ago in which he had given some data concerning the effects of varying speeds of rotation on the density and soundness of centrifugally made castings in phosphor bronze and other metals, including aluminium, cast iron and various brasses. He spoke particularly of a differential gear blank made in phosphor bronze by the semi-centrifugal process revolving about a vertical axis, the outside diameter of blank being formed by a cast-iron ring and the internal diameter by a core. The gear blank weighed approximately 62 lbs., when made in a static sand mould. The normal rotational speed was 300 r.p.m., which was equal to a peripheral speed of something like 1,150 ft. per min. The density of the casting was 8.54, at that speed. When the speed was raised to 1,925 ft. per min., the density was 8.69; at 2,400 ft. per min. the density was again 8.69; and at 3,100 ft. per min. the density was 8.71.

Weight of Gear Blank

The weight of the gear blank, after machining, was heavier when cast centrifugally than when cast in an ordinary sand mould. When sand cast it had weighed 62 lbs. When spun at 1,150 ft. per min. it weighed 65 lbs.; at 1,925 ft. per min., 65½ lbs.; at 2,400 ft. per min., 65 lbs.; and at 3,100 ft. per min., 68 lbs. Thus, with increasing speed of rotation the density of the casting increased. With regard to the mechanical and physical properties, the tensile strength of the statically cast blank was something like 14 tons per sq. in., and the elongation was about 12.3 per cent. He had not tested the blank which was spun at 3,100 ft. per min.; but that which was made at 1,925 ft. per min. had a tensile of 20.1 tons per sq. in., and an elongation of something like 18 per cent. Evidently, therefore, the increased speed of rotation was beneficial in the case of gear blanks when made of phosphor bronze.

As to the possibility of avoiding vibration, Mr. Longden wondered why both Dr. Hurst and Mr. Kain had missed one excellent reference to the control of variable speeds by hydraulic power. Mr. J. Tranton, President of the Youngstown Steel Corporation, had had the idea of using hydraulic power to solve the problem of variable speeds, instead of using motors or pulleys. He had solved the problem over an extremely wide range. The rotation was very smooth throughout the operating range. Speeds up to 560 r.p.m. were referred to. The first of the molten steel was poured at 100 r.p.m.; as soon as the mould was filled, the speed of rotation was increased as rapidly as possible to full speed, as determined by the size of casting.

In centrifugal casting it was important to avoid the possibilities of cold shut. If at the commencement only a small quantity of metal entered the spinning

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mould, the following metal would probably fail to amalgamate with it. Therefore, the object was to run the machine at a slow speed at the commencement, and to put in as large a volume of metal then as possible, in order to prevent striation; one should then increase the rotational speed as rapidly as possible, and gradually reduce the rate of pour until the casting and feeding was complete.

More Efficient Thermal Contact

Mr. M. M. Hallett (Member), endorsing Mr. Twigger's request for further information on the effect of the speed of rotation on the properties of the castings produced, said that it might have been supposed that a more efficient thermal contact between the solidifying metal and the wall of the mould would result from the higher speed of rotation, and that this would be associated with a finer grain size in the casting. However, he himself had not observed any such effect nor did there seem to be much published information: anything which Dr. Hurst could add would increase still further the value of the Paper. With regard to Fig. 1, he suggested that of the two methods of dealing with the problem of acceleration of liquid metal, or pick-up, as it was often called, greater attention was usually paid to the peripheral speed. It would be interesting to reverse the direction of rotation of the die, and he wondered what would be the effect on "pick-up" of the violent turbulence induced by such a sudden change in direction of metal flow.

As to the effect of vibration and its association with mould speeds mentioned by Mr. Peace, Mr. Hallett remarked that serious banding and segregation did occur in certain alloys at critical speeds, and that vibration was usually regarded as the cause of the trouble. The matter had been investigated in considerable detail by a Government department, and he understood that a Paper was to be presented to another metallurgical institute.

Mr. T. Henry Turner, M.Sc., A.M.I.Mech.E., M.I.Loco.E. (Member), suggested that it was not legitimate to group all metals and alloys in such a discussion. Surely, he said, the process must produce one type of result with alloys having a large gap between the liquidus and solidus, when the metal was pasty or plastic; but the sudden solidification of eutectics must produce quite a different type of result, unless the cooling was very rapid in all cases. When talking of centrifugal casting one was thinking mostly of cast irons or babbitt-type white metals, but in many systems one could find a eutectic alloy which might behave quite differently. He asked if Dr. Hurst could elaborate that point.

Mr. H. Forrest (Member) mentioned some experiments in which it was sought to increase the tensile strength and En value of an unalloyed grey iron by varying the speed of rotation of the mould. The speeds at which the experiments were made were 1,500 ft. per min. (25 ft. per sec.), and 1,875 ft. per min. (32 ft. per sec.), and there was no appreciable difference in respect of either the tensile strength or the En value. Every effort was made to ensure a straight comparison. The tests were made with similar dies, the temperature of the metal in each case was identical, and it was poured from the same ladle. He believed that vibration caused mould dressing disturbance, which led to casting faults such as inclusions. He had noticed that at times when machines had been in need of repair the amount of scrap resulting from the operation of those machines was increased.

Mr. H. J. Young (Member) wrote asking whether what the Author called "wetting" means physical contact between the boundary of the fluid metal with that of the mould surface. If so, did it not follow that the cooling of an iron cast into a metal mould rotating more quickly than usual, was affected, as also its structure and properties? Of course, it was being assumed that the metal and mould temperatures were the same in each case.

When he (Mr. Young) went from sand-cast to centrifugally-cast work for the first time he met something he had not expected. In the sand foundry certain cylindrical castings were mass-produced in green-sand moulds-cum-cores. They had to be very free-machining, and their carbon, silicon, phosphorus, sulphur and manganese contents were controlled within close limits. In the centrifugal foundry he found that the same castings used for the same engineering purpose were cast with an iron so similar as to be well nigh identical. He, therefore, arrived at the conclusion that the temperature of the metal mould used in the centrifugal foundry produced a rate of cooling through the critical points not dissimilar to those occurring in a green-sand mould. Later, he proved to his own satisfaction that compositions suitable to a sand-foundry were equally suitable to a centrifugal one, and that the operatives in a centrifugal foundry did in fact make their mould temperatures suit the iron they were using, and this without outside assistance. This did not suggest that one could not find something which would suit one method and not the other. As far as he could observe, these results were not arrived at by control of mould speed to suit the composition of the molten iron, but Dr. Hurst's Paper now caused him not to feel so sure about it.

Mr. E. Longden wrote:—During the discussion his remarks on the effects of rotational speeds on density had reference to metals of high liquid shrinkage characteristics, such as phosphor bronze. Tests on steel castings spun at varied speeds indicated a progressive improvement in density, with increasing speeds up to about 2,000 ft. per min. Above this rotational speed further improvement in density was not indicated with any degree of clearness. Intensive tests on spun cast irons indicated quite plainly that there was little increase in density even at the maximum speeds of the machine. Actually, gear blanks made in a static mould with a cast-iron ring densener around the periphery proved to be as dense and sound as castings spun cast at the highest rotational speed with a similar mould condition as obtained for the static cast.

Author's Reply

Dr. Hurst wrote:—On reading through the discussion he recognised that each contribution was concerned with the influence of speed of rotation on some aspect or other of the properties and characteristics of the castings produced. It was perhaps desirable to repeat that in the Paper he had confined his attention to a review of the conditions of speed in the various centrifugal casting processes that have been proposed or adopted commercially. Rotational speed was only one of the conditions, and its effect on the properties and characteristics of the castings must be considered in relation to the particular process—the manner in which the rotational velocity is applied and acquired—the method of pouring and the pouring conditions—the character and surface characteristics of the die or mould—the dimensions of the castings, and the by no means unimportant factor, as recognised by Mr. Turner, the nature and type of alloy cast.

To deal effectively with the various aspects of the subject, as raised in the comments by Mr. Twigger and others, demanded a further Paper. In the reference to the possibility of hot tears occurring, it might have been made more clear in the Paper that this occurrence was more likely to happen when dealing with the production of castings in steel. Personal observation confirmed that of Mr. Twigger, that hot tears were rarely met with in the centrifugal casting of cast-iron cylinders, but then for that matter hot tears were not a common occurrence in grey iron and castings of this type.

The two matters raised by Mr. Peace are of great interest and importance. It is possible to visualise advantages accruing from the use of higher speeds or more properly higher velocities than those normally employed. The use of higher velocities, however, introduces problems in the design and construction of the casting machine, and vibration is one of the problems and by no means the least. The importance of vibration has been realised, and its effect particularly in connection with the structural character of castings has been studied as indicated by Mr. Hallett. The desirability of controlling vibration and its effect involves matters relating to the design and construction of the machines.

The information given by Mr. Longden was of interest. The figures given were presumably specific gravity determinations of the castings as a whole, produced under the conditions of rotational velocity stated. He was aware of the possibilities of the use of hydraulic transmission and speed variation mechanism in the design of centrifugal casting machines. Pouring on the opposite side of the perpendicular plane through the axis of rotation to that illustrated in Fig. 1 would achieve the same results as reversing the direction of rotation of the die visualised by Mr. Hallett. Under certain conditions there was a good deal to be said for this method of pouring.

The tests reported by Mr. Forrest were of great personal interest, and he wondered if Mr. Forrest had explored the distribution of tensile strength and En value across the radial wall thickness of the castings and whether any difference in distribution was found. He had used the term "wetted" surface in the sense used in physics in dealing with surface tension phenomena in liquids. Whilst he had said that molten metals did not "wet" the surface of the rotating moulds, he found himself in some difficulty in understanding the point of Mr. Young's remarks. Finally, he wished to thank all those who contributed to the discussion for their interest in the Paper, especially Mr. Kain, who undertook to present the Paper at short notice.

Apparent Inconsistencies

Mr. O. R. J. Lee wrote:—This Paper by Dr. Hurst is a comprehensive survey of published data on centrifugal casting speeds and the resulting comparison of various practices is most valuable. It reveals many apparent inconsistencies and variations from theoretical principles. The latter no doubt arise from attempts to forecast behaviour under unknown conditions on the basis of insufficient evidence when the correct course, as Dr. Hurst mentions more than once, is experimental determinations, having regard to the particular requirements of the process. It is unfortunate that so many authors attempt to force their experimental data into theoretical equations without ascertaining the applicability of the implied theoretical principles under their practical conditions.

These equations can be divided into two types:—

$$N = \frac{K}{\sqrt{R}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (a)$$

$$N = \frac{K^1}{R} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (b)$$

Introduction of the appropriate figures involved in the constants indicates the relative significance of the equations which become:

$$N = \frac{\sqrt{900g}\sqrt{\frac{C}{G}}}{\pi\sqrt{R}} = \frac{187\sqrt{\frac{C}{G}}}{\sqrt{r}} \qquad \ldots\ldots\ldots (c)$$

$$N = \frac{\sqrt{1{,}800g}\ \sqrt{P}}{\pi R\sqrt{\gamma}} = \frac{265\sqrt{P}}{r\sqrt{\gamma}} \qquad \ldots\ldots\ldots\ldots (d)$$

where C = centrifugal force on a particle,
G = gravitational force on the same particle,
$\frac{C}{G}$ = "times gravity" acting,
g = gravity acceleration ft. per sec. per sec.
R = radius ft.
r = radius in.
γ = density of liquid metal, lbs. per cub. in.

Equations of type (*a*) are thus based on maintaining a constant "times gravity" value, whilst equations of type (*b*) involve the building up of a fixed internal pressure.

If the peripheral velocity is V ft. per min.,

Centrifugal Casting Process

$$V = \frac{2\pi N r}{12} \quad \ldots\ldots\ldots\ldots (e)$$

and equation (d) can be written,

$$P = \frac{36\ \gamma V^2}{10225\pi^2}$$

$$= 0.516 \times 10^{-5} \gamma V^2 \text{ lb. per sq. in.} \quad \ldots (f)$$

Hence the adoption of a constant peripheral velocity is equivalent to the use of a constant internal pressure.

The above pressure equations (d) and (f) apply only to conditions in which liquid metal extends from the periphery to the axis of rotation, as it does in centrifugal pressure (or die) castings and in vertical axis casting with a central core. It is to be hoped that the term semi-centrifugal process applied to the latter will not gain permanent acceptance, since it is even a looser term than the objectionable "semi-steel."

In the more general case, and when applied to centrifugal casting without a core, equation (f) becomes

$$P_1 - P_2 = 0.516 \times 10^{-5} \gamma V^2 (1 - k^2) \text{ lb. per sq. in.}$$

where $k = \frac{r_2}{r_1}$

In a typical casting 10 in. dia. and 1 in. thick, $\frac{r_2}{r_1} =$ 0.8 and $1 - k^2 = 0.36$, so that the maximum pressure developed is only about a third of that if metal existed up to the centre line. The derivation of the pressure equation (5) in the Paper is rather loose, since radial inegration does not take all the factors into account. Equation (5) in the Paper is, however, a valid expression of the pressure expressed in fundamental force units; reduced to practical units it becomes

$$P_1 - P_2 = 1.415 \times 10^{-5} \gamma N^2 (r_1 - r_2^2) \text{ lb. per sq. in.} \quad \ldots (g)$$

The application of these equations to practice is rendered inexact because of two assumptions which have to be made:—(1) The metal is rotating at the same speed as the mould; and (2) the metal is rotating at constant angular velocity.

Both these assumptions are least valid for coreless castings and become virtually correct for pressure castings and the vertical axis castings in which the metal flows from the runner to the periphery in restrained channels, as along the arms of a wheel casting.

Theoretical Calculations

Assumption 1 is invalidated by the amount of "slip" between the metal and the mould, as discussed in the Paper. It may well be that the liquid does not attain the speed of the mould until solidification sets in, causing a substantial increase in viscosity. The influence of increasing the rate of solidification by employing more effective cooling of the Lavaud mould is mentioned in the Paper to have reduced the rotational speed by one-half. Alternatively, the use of a sand mould delays the viscosity increase during solidification and higher speeds have to be employed to obtain satisfactory pick-up. Theoretical calculations may thus be in serious error due to this assumption. The question of slip and pick-up does not arise in pressure castings and in the arms of spoked wheel castings, because the mould shape forces the metal to conform to its own velocity.

Assumption 2 is invalidated in horizontal coreless castings if Fig. 4 of the Paper is applicable, since liquid at the top of the mould will have to pass through the thin layer position at a more rapid rate than through the thick layer position at the bottom of the mould. In the Paper it is not made sufficiently clear that R in Fig. 4 is the outside radius of the *liquid* and that, when solidification commences as a thin shell of uniform thickness, the value of R would steadily fall as solidification proceeds. R_1 remains virtually constant and so $R - R_1$ diminishes until at the final moment of solidification $R = R_1$, and a casting with concentric bore would result. Although the effect sketched in Fig. 4 is therefore of secondary importance, some experiments have been made by rotating liquids in circular moulds and observing the shape of the free inner surfaces. A brass tube 5.05 in. internal diameter was fitted with glass ends and coloured water run in. The whole was gripped in a lathe giving a maximum speed of 450 r.p.m. This would only "pick-up" a water thickness of $\frac{1}{4}$ in., but, once picked up, the speed could be reduced to 385 r.p.m. without the water falling away from the mould. At these two speeds, photographs show that the liquid layer was concentric to within $\frac{1}{64}$ in., whereas calculation by equation (3) gives an eccentricity of 0.24 in. at the lower speed.

To obtain a thicker layer of liquid and also a reduction in rotational speed, a sodium silicate solution was used which picked up at 250 r.p.m. to give a liquid layer $\frac{15}{32}$ in. thick. Once picked up, a speed of 210 r.p.m. would maintain the liquid clinging to the sides of the mould. Photographs under this condition showed a slight eccentricity of $\frac{1}{32}$ in., but the horizontal and vertical diameters of the free liquid surface also differed by this amount, which is considered to be insignificant. The calculated eccentriciy was 0.8 in. The assumptions underlying the derivation of equations such as 3 and 4 in the Paper do not therefore lead to results in accordance with practice.

As Fig. 5 of the preprint shows (misprint, 200 for 1,200 ft. per min. on the left-hand curve) adjusting the speed of the mould to give a constant "times gravity" rather than constant peripheral velocity usually results in higher speeds of rotation being employed. It is now suggested that the true theoretical criterion for centrifugal casting is the maintenance of a minimum internal liquid pressure (varying for different types of casting and different types of mould), and it is thought that the use of a mould speed equation following a relation of constant "times gravity" is merely an attempt to give theoretical support to an arbitrary procedure for obtaining pick-up. If actual observations of satisfactory mould speeds were fitted into an equation of the form

$$N = Kr^{-x}$$

x would be probably found to lie between the value of $\frac{1}{2}$ (indicating constant "times gravity") and 1 (in-

(*Continued on page* 245, *column* 1.)

THE MECHANISED PRODUCTION OF ALUMINIUM GRAVITY DIE-CASTINGS FOR THE MERLIN ENGINE

A resume of production methods used is given in this instalment.

By JOHN VICKERS

(*Continued from page* 220.)

PART II

Production and Inspection

The total floor area of the die-casting foundry covers 22,500 sq. ft., the area occupied by the production departments being limited to 13,500 sq. ft. The remaining 9,000 sq. ft. of this section includes the spacious gangways and the annexe, which consists of the production offices, laboratory, despatch stores, cloakrooms and lavatory accommodation, etc.

Fig. 23 shows the layout of the foundry and illustrates to what extent mechanisation has been introduced for the purpose of obtaining maximum output. Each operation in this production foundry will be described in detail at later stages, but it is felt that a general *résumé* of production methods used would, at this point, be of appreciable assistance to the reader in familiarising himself with the flow of work through the foundry from the receipt of the ingot material to the despatch of the finished castings to the machine shops.

The ingots are transported in sheet metal stillages by electric elevating platform trucks from the central raw material stores located in the parent foundry, to

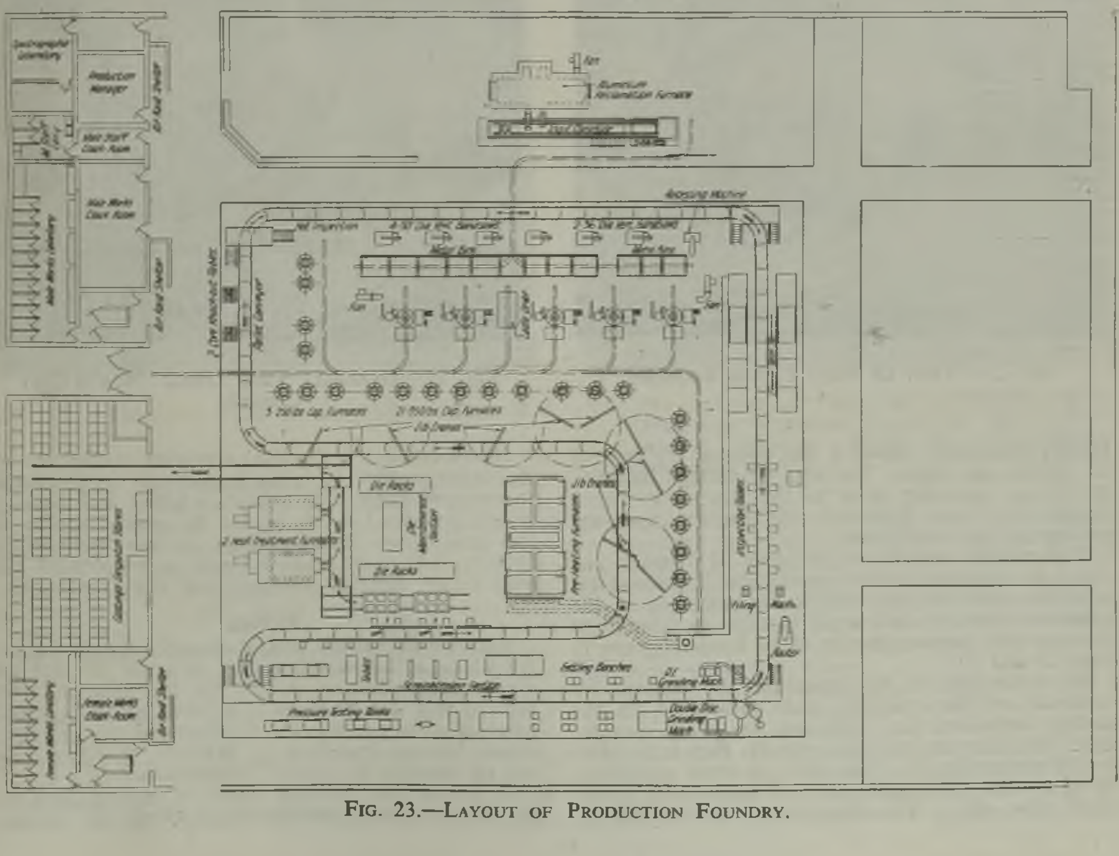

FIG. 23.—LAYOUT OF PRODUCTION FOUNDRY.

Aluminium Gravity Die-Castings

be melted in the tilting furnaces, which can be seen in Fig. 27. From here the molten alloy is transferred, by crane ladle suspended from a monorail conveyor, into maintaining furnaces from which the diecasters ladle the metal for pouring the castings.

When extracted from the die, the castings are placed on a flat plate conveyor, which travels throughout the foundry, passing through every section. This conveyor, loaded with castings, can be seen in Figs. 33 and 34, leaving the casting bay. Another section of the foundry is illustrated in Fig. 24, where the castings are also shown being transported by means of this pallet conveyor.

Upon leaving the casting bay, every casting receives a visual, or what is commonly known in the trade as a "hot," inspection before passing to the first of the fettling operations, which is the removal, by saw, of all runners and risers. The semi-diecastings, however, receive an operation prior to this, known as "core knock-out," which is actually the removal from the castings of the sand cores.

This surplus metal, in the form of runners and risers, is deposited in sheet metal bins positioned behind the saws, to be available for remelting in the adjacent furnaces—their exact location in relation to the saws and furnaces can be noted from reference to Figs. 25 and 26.

On completion of this operation, the castings are replaced on the conveyor and transported to the second inspection, *viz.*, chalk test, for which they receive the following treatment—firstly, they are soaked in oil tanks (Fig. 39), then dried in trays containing wood sawdust, and finally they are dusted with french chalk (Fig. 40). The inspection is carried out by female inspectors seated at benches further along the conveyor, as can be seen in Fig. 41.

The castings passing this chalk test are conveyed next to the fettling section, where the remaining fettling operations are carried out, either by machine or by hand, dependent upon the nature of the casting; and from here are transported by the conveyor to the final dimensional inspection department (Fig. 53).

Where castings are called upon to withstand a certain pressure, before they are allowed to pass to final inspection, a pressure test is taken and, making reference to Fig. 24, in the bottom right-hand corner will be seen the water tanks where the test is made. Other types of castings such as those having long thin sections, like the rocker covers, during the various production operations are liable to slight distortion in handling, and, if found so at final inspection, they are returned to the straightening section for rectification.

FIG. 24.—VIEW OF WEST END OF FOUNDRY.

FIG. 25.—GENERAL VIEW FROM NORTH-EAST CORNER.

Heat-treatment is the final operation carried out on the castings prior to being despatched *via* the stores to machine shops. This brief synopsis will have, it is felt, portrayed to the reader the general routine in the production of die-castings in this Rolls-Royce foundry, and it is proposed now to supplement this with a fully detailed description of this production.

Melting

Rolls-Royce believe that a diecaster should diecast, the whole of his working shift, in order to yield the maximum production output for any one die. To achieve this, the diecaster is relieved of all responsibility of metal melting and, furthermore, his own particular furnace, known as a "bale-out," is always kept full of metal at the correct temperature.

To ensure this constant supply of molten metal at the required casting temperature, a system of "duplexing " has been adopted, *i.e.*, primarily melting, degassing, etc., in a battery of large tilting furnaces and transferring the molten alloy into another set of " bale-out " maintaining furnaces, which serve merely as a reservoir from which the diecaster works.

For the purpose of melting, a battery of five " Morgan's " central-axis tilting crucible furnaces of 5-cwt. aluminium capacity is employed. These are fired by producer gas, with the piping so designed that, in the event of supplies becoming restricted or terminated completely, conversion to town's gas could be carried out with the minimum of loss to production. To maintain the molten alloy at the correct casting temperature, a batch of " Morgan's " bale-out crucible furnaces is used, 21 of which are of 350 lbs. and three of 250 lbs. aluminium capacity, using the same heating medium. By this means the foundry is assured of having available for one week's production 100 tons of molten aluminium.

To convey the alloy in its molten state to the maintaining furnaces, sheet iron worm and bevel geared crane ladles are used, being suitably lined with " Durax " refractory material, in order to retain the heat in the molten metal and also to avoid iron " pick-up " by the aluminium. The gears are totally enclosed, running continuously in a bath of oil. This ensures their long life, while excluding all grit and metal splashings.

FIG. 26.—GENERAL VIEW OF SOUTH-EAST CORNER.

It is essential that loss in temperature of the molten alloy, while being transferred from one furnace to the other, should be limited as much as possible and, with this end in view, a heating unit was designed to heat the ladle. prior to pouring, to prevent the metal from being chilled on entering the ladle from the melting furnace. To obtain this desired effect, a flame is thrown downward from the centre of a ganister lined hood into the bowl of the ladle, the hood being pivotted on a steel stanchion to allow it to be swung clear when positioning the ladle.

The method of transportation is by an overhead monorail conveyor, the runway of which is constructed of 12 in. by 5 in. by 30 lbs. per ft. rolled steel joists to carry a safe-working load of 1 ton. About 300 ft. of track has been used to cover the various furnaces, the straight sections being machine straightened and the curves accurately formed to template to ensure the absence of the slightest distortion at any point. Bare conductors, three in number, are fitted along this track to convey the current to the motors of the electric blocks; they are supported by means of insulated brackets attached to the track girders, and they are so arranged that the motor of the electric blocks can be operated at any point on the runway track excepting where the trolleys pass over a junction.

The trolleys are fitted to run along the lower flange of the track on four turned ungeared runners on ball bearings, being constructed on the bogie principle to pass round the curves and fitted with switching gear to negotiate the various junctions. Attached to each trolley are three collectors for making contact with the bare conductors, and suspended from each is a 1-ton electric block which is capable of lifting the full load on four falls of steel wire rope at the rate of 20 ft. per min., being controlled from floor level by means of suspended cords.

FIG. 27.—BATTERY OF MELTING FURNACES, WITH OVERHEAD MONORAIL CONVEYOR FOR TRANSPORTING MOLTEN ALLOY TO MAINTAINING FURNACES.

To transfer to the maintaining furnaces the ladle is tilted by means of the handwheel, and the molten alloy flows into a pouring trough, one of which is situated alongside each furnace. It is inclined at an angle of 10 deg. to ensure smooth flow, and has a lining of about 1 in. thick ramming material. To keep the mouth of the furnace clear for the diecaster, the trough

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is mounted on a column of 3 in. bore gas tubing, working with a swivel movement on a steel pivot and a brass thrust washer, so that it can be swung clear immediately the transfer has been completed.

As there are usually four or five different alloys in use at the same time, great care must be taken lest one alloy be transferred from the melting furnace and poured into a maintaining furnace containing an entirely different alloy. As an additional precaution against this possibility, large metal labels are attached to each furnace showing the alloy contained by that particular unit.

The melting, fluxing and transfer of metal from the melting furnace is, at all times, carried out under the strict supervision of a member of the laboratory

Fig. 28.—Molten Aluminium being Poured from Melting Furnace into Ganister-Lined Ladle for Transferring to Maintaining Furnaces.

staff, who also records, in the furnace record book, particulars of melt number of ingot material in the charge, the percentage of scrap addition, temperatures, and the furnace number in which the metal is both melted and maintained. The part number or numbers being cast from each maintaining unit is also recorded, thereby co-relating the raw material with the finished casting.

Casting

Since the die development department has specified all the essential features to ensure production of sound castings, the production foundry is thus able, upon receipt of the die, to go ahead with manufacture without any difficulty other than that of normal die maintenance.

Efficiency cannot be obtained from a gravity die which is in operation continuously, and it is therefore the practice in this section to have one set of dies in production on one shift only, so that the necessary coating and preparation on them may be accomplished during the following shift in readiness for the commencement of production. This also has the advantage of facilitating scrap identification, as only one operator or squad of operators has been producing from that die during a particular period.

Preheating and Preparing Dies

Before commencing casting it is essential that the temperature of the die should be raised to receive the molten alloy, and for this purpose a battery of preheating furnaces has been installed. These furnaces, eight in all, are oil-fired through two common fire-boxes, and they are heated by means of hot air passed through tortuous passages arranged down one side of the fire-boxes and then passed into the two flues

Fig. 29.—Molten Alloy being Transferred from Crane Ladle to Maintaining Furnace by Means of Ganister-Lined Pouring Trough.

arranged for supplying the hot air to the furnaces. Each furnace of the unit is controlled separately by dampers operated from the outside, the temperature being taken by means of independent pyrometers and recorded on a 24-hr. chart of a "Cambridge" wall-type recorder. The door of each furnace, operated independently, is counter-balanced, to permit easy lifting and lowering, by balance-weights suspended at the end of a steel wire rope run over a pulley, mounted on ball-bearings, located on top of the unit.

The racks, which were specially prepared to carry the dies while undergoing this process of pre-heating, are of simple design, being constructed of good-quality cast-iron castings bolted together. The two shelves are each 3 ft. 3 in. by 2 ft. 6 in. by ½ in. and are 2 ft. apart, the bottom one being 1 ft. from ground level, and in each have been provided twelves holes of 4 in. dia. to enable the hot air to circulate freely around the dies while in the furnace. The racks have been so constructed that the top shelf can be removed by crane to eye-bolts located at each corner, without interfering with the remainder of the structure. This has proved to be a great asset, as its removal is often necessary to facilitate handling of the dies positioned on the lower shelf.

Transportation of the racks into the furnace is carried out by means of hand elevating trucks fitted with hydraulic release checks which cushion the descent of the load, and thus ensures that the dies are not disturbed while being placed in the furnace.

Great care is taken to ensure that all traces of old coating are removed and that the die has been thoroughly cleaned prior to its first entry into the furnace in the preheating process. During this first period the temperature is steadily raised until the die is considered to be about 200 deg. C., when it is removed from the furnace to receive fresh spraying of die-coat to the specification as laid down in the standard layout presented with the die by the die development department. After receiving this treatment the die is placed back on the rack and returned to the furnace, where it is allowed to remain until just prior to the commencement of the following shift, the temperature in the furnace during this second stage of the process being between 300 and 350 deg. C.

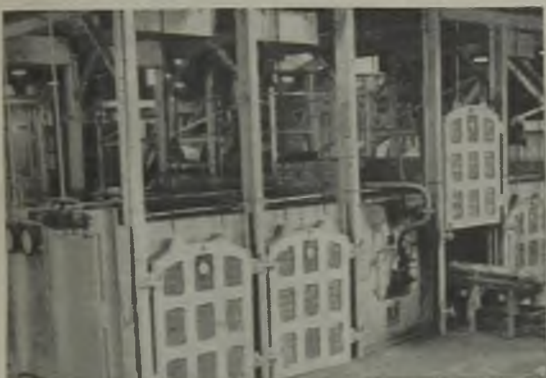

Fig. 30.—General View of Battery of Preheating Furnaces Showing "Rocker Cover" Die Being Placed in Heating Chamber.

Before each shift, the dies are removed from the furnace and clamped to the respective die-tables situated at the maintaining furnaces, gas burners being employed for the purpose of retaining the heat in the die until such time as the casters commence production. This procedure ensures that there is no unnecessary loss of production, which would be the result if no preparation had been made and the setting-up left to the die-caster at the commencement of the shift.

Pouring

The die-casters are graded according to their individual skill, so that they can be allocated to the die most suited to their particular ability; thus a Grade . caster is assigned to a multi-core die or placed in charge of a die requiring two or more operators. A Grade II caster is normally detailed to a comparatively simple die, while a Grade III or trainee operator usually occupies a subordinate position in a casting "pool." By operating this system production scrap is automatically reduced and at the same time assurance is obtained that the best possible service is being obtained from the available labour.

The metal is ladled out of the maintaining furnaces for pouring into the dies by means of wrought-iron hand ladles, which are, at all times, well coated with whitewash, thus ensuring that there is no iron "pick-up" by the aluminium.

Prior to commencing casting, the operator is always acquainted by the foreman of all relative details, as outlined in the standard layout, concerning the casting about to be produced. The method and speed of pouring is controlled by this tabulation, but special attention is given to ensure that at all times the minimum of turbulence is present in the molten alloy. Another item of particular importance is the time which must be allowed for the casting to set, to guard against the part being extracted from the die too early in the period of solidification, thereby causing a fracture in the casting and, therefore, to enable the caster to work accurately to the time stipulated, synchronous electric clocks, with seconds hand, fitted with 10-in. dia. dial, have been installed throughout the section within view of all operators, thereby assisting them in obtaining sound castings by devoting special attention to this consequential factor.

Fig. 31.—Die-Rack Loaded with Dies being Placed in Heating Chamber.

Gaseous fumes, resulting from the combustion of the heating medium, and also the reaction of the aluminium upon the degasing reagents, emanate from the maintaining furnaces, resulting in some discomfort to the casters, but this unpleasantness has been

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reduced considerably by the installation of a suction exhaust system. Sheet metal hoods are erected directly above the furnace tops, so that the absolute minimum volume of fumes is allowed to contaminate the surrounding atmosphere. The ducting through which the fumes are extracted increase in diameter from 1 ft. 3 in. at the hoods to 4 ft. at the "Keith Blackman" impeller fan, which provides the suction power, being driven by a 25-h.p. motor, and it is capable of passing 32,000 cub. ft. of air per minute. It is situated above the girders at the roof, so that the fumes are released to the air outside the building.

Additional to improving working conditions for the die-casters, the installation of this exhaust system automatically resulted in the amelioration of general atmospheric conditions throughout the entire foundry.

In order to satisfy himself that he is operating the die in the proper manner and that no obvious faults are present, the caster normally superficially inspects the casting while awaiting the setting of the following casting poured, and if this assurance is obtained, the part is then released to the next operation. In the foreground of Figs. 33 and 34 a caster can be seen carrying out this examination on a casting prior to its release.

Fig. 32.—"Single-Handed" Pour of "Tilting" Die.

The problem of transporting castings between operations has been eliminated by the installation of a flat plate conveyor travelling throughout every department in the foundry. To embrace all sections in this project 550 ft. of conveyor was necessary, comprising of 110 pallets each being 5 ft. long, with a width of 2 ft. 6 in., and joined together to form a continuous platform. A 2 in. thick covering of reinforced "insulating aggregate" is built above the plates to prevent the heat from the castings damaging the mechanism, and to protect the insulating material from becoming chipped with the continual movement of castings, $\frac{3}{16}$ in. thick covering plates are fixed on top in such a manner as to serve also as a guard over the pallet joints. Each pallet is mounted on a bogie fitted with swivelling flanged wheels suitable for running on flat-bottomed rails, which are supported on angle iron structure so that the pallet face is 2 ft. 6 in. above floor level.

The conveyor is driven by means of compressed air from a 12-in. dia. air cylinder, which delivers a stroke of 5 ft. The driving pawls, which connect to the bogie axles, run on a 6-ft. length of flat-bottomed rail track situated at floor level immediately behind the cylinder, and operated in conjunction with them is the cam rod which alternately opens and closes the control valves at each end of the cylinder and thereby provides the traction and reciprocating motion; the entire movement of the conveyor thus becomes automatic. Throttle valves, fitted at either end of the cylinder, enable the rate of travel to be regulated—the speed ranging from between 9 in. to 10 ft. per min.

Fig. 33.—View of Line of Die-Casters at Work.

An independent driving unit is installed to act as a spare so that, in the event of mechanical breakdown to the one in operation, it can be put into commission immediately, thereby ensuring that the production output is not affected in any way by lack of transport facilities for conveying the castings from one operation to another. A section of this pallet conveyor may be seen in Figs. 33 and 34 carrying castings, newly produced, from the casting bay to receive the next operation.

Core Knock-out

This term is applied in general in the foundry industry, to the removal of cores from the casting, but in die-casting, where practically all cores are of metal and are normally abstracted prior to the removal of the casting from the die, "core knock-out" refers merely to the extraction of the sand cores from the semi-diecast parts. All castings in this category are removed from the conveyor at the end of the line of die-casters for the purpose of clearing the internal passages of sand.

Fig. 35 illustrates the unit designed to simplify and expedite this core knock-out operation. It is a simple angle-iron construction, the table-top being in the form of a grid, which allows the extracted sand to pass through into a sheet-iron bogie positioned below. A No. 1 "Cleco" pneumatic hammer is clamped round the barrel to a fixture at a comfortable working level, the trigger being fixed in the compressed position so that when the riser of a casting is pressed against the chisel blank protruding from the nozzle, the required vibrating action is immediately obtained. This vibration of the casting causes the core sand within to be broken up, thereby simplifying the clearing of the internal passages.

Visual Inspection

One of the principal features in the management of

FIG. 34.—ANOTHER VIEW OF LINE OF DIE-CASTERS AT WORK.

this foundry has always been the employment of labour on only duties essential to maximum output. It is in this effort that various inspections have been instituted, throughout the departments between operations, to ensure that labour expended on scrap castings is limited to the absolute minimum. Thus, at the end of the die-casting line of the conveyor, the visual or "hot" inspection section is situated so that all visual scrap is rejected before any further work is carried out on the castings.

The inspector paints a distinct marking on the scrap showing also whether or not the cause is attributed to the fault of the operator. This rejection and cause is recorded at this stage, to allow a complete summary and analysis of the total scrap to be made later, so that the management is in possession of the full facts, thus enabling prompt action to be taken if considered necessary.

Fettling

The castings which have been passed as satisfactory by this inspection are returned to the conveyor, on which they proceed to the band-sawing section.

Sawing.—Every casting produced has a certain amount of surplus metal, in the form of either runner or riser, and this is removed by the use of band-sawing machines. To cope with the rate of production, for

FIG. 35.—SAND CORE BEING KNOCKED OUT OF COOLANT PUMP CASING.

this operation the section is equipped with six electrically driven vertical band-sawing machines which are capable of cutting aluminium alloys up to 4 in. thick. Four of these machines are fitted with 30-in. dia. wheels and the remaining two with wheels of 36 in. dia. all being driven by multiple vee belts and controlled by "start" and "stop" push-buttons.

The larger castings, which normally bear a heavier section of surplus metal which has to be severed, are sawn on the larger type of machine and, from experience, it has been found that the most suitable and also most serviceable blades for this particular class of work are 18 G. x 5 teeth per inch, being 19 ft. 6 in. in length, with a breadth of 1¼ in. Blades working on these machines operate normally for five cutting hours before they require to be removed for sharpening and setting.

The 30-in. dia. machines are employed where the

Aluminium Gravity Die-Castings

section of metal to be sawn is much lighter and, dependent upon the particular cut required, alternative breadths of blades are operated, the actual dimensions being ¾ in. and 1 in., in both cases the remaining sizes being 17 ft. long x 19 G. x 6 T.P.I. On an average, the normal life of these blades is approximately 7 hrs. before requiring to be sharpened.

When the runners and risers have been removed, the castings are returned to the conveyor and the surplus metal is deposited in the sheet metal bins positioned behind the band-saw machine, as illustrated in Fig. 37. Great care is required in the disposal of this scrap to ensure that the various alloys are not mixed, and for this reason it is endeavoured as far as possible to

Fig. 36.—Riser of "Diffuser Vane Ring" Casting being Cut Off on a "Midsaw" 4-Speed 30 In. Dia. Bandsaw.

confine one alloy to one particular saw. Another precaution taken is that the scrap bins are stencilled, in 6-in. letters and figures, with the reference by which the various alloys are known.

From one particular part, the front gear-case cover, this surplus metal in the form of risers cannot be removed by means of sawing on these band-sawing machines owing to the method employed to feed the three heavy bearing bosses, as described in detail in the "die development" section. These bosses are cast solid so that, to remove the excess head metal, a form of machining operation is required, and this is executed by recessing the bores by means of a fly-cutter.

Fig. 38 shows a casting set-up on a Wadkins'

Fig. 37.—General View of Line of Bandsaws.

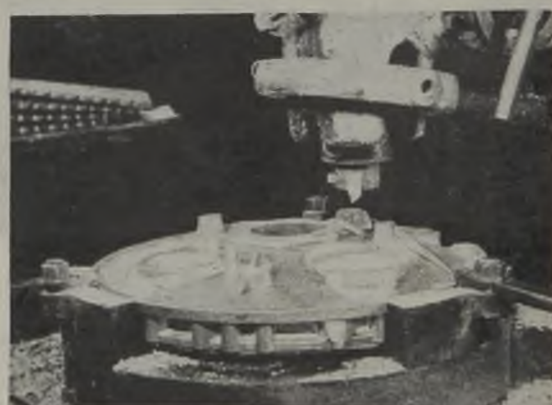

Fig. 38.—Recessing Bores of Front Gear Case Cover.

Model LQA boring and recessing machine, to receive this operation. The castings replaced on the conveyor proceed from the sawing section to the chalk test section, where every individual casting undergoes a further inspection, but prior to entering this section each casting is stamped with ⅛-in. steel types, so that the date of casting the part becomes a permanent fixture, thus making possible the correlation of the production records.

(To be continued.)

SPEED OF ROTATION IN THE CENTRIFUGAL CASTING PROCESS

(*Continued from page* 236.)

dicating constant pressure and peripheral velocity), tending to be lower, the greater the amount of slip between the mould and the metal.

The equation at the top of page 7 of the preprint is a misprint for $N = \frac{1,600}{\sqrt{R}}$

Differences in Speed Conditions

DR. HURST wrote: I am very appreciative of the written contribution to the discussion on my Paper received from Dr. Lee. In my Paper I have been concerned with the rotational speeds recorded as having been adopted in the various casting processes. It is quite evident that differences in speed conditions have been adopted by different operators, and that they have been determined experimentally having regard to the particular individual requirements. In my opinion such differences or inconsistences in themselves are evidence of experimental determination of the speed conditions.

The experimental investigation of the conditions indicated in my Fig. 4 recorded by Dr. Lee are of considerable interest. The fact that the degree of eccentricity under the conditions described is less than the calculated values is in line with some results of my own obtained by rotating liquid mercury in a large diameter mould approximately 24 in. dia. Whilst I have not been able to lay my hands on the figures, my experiments having been carried out as far back as 1921, my recollection is that the departure from the theoretical was not nearly so great as observed by him. I find that quite unthinkingly I have drawn the diagram Fig. 4 somewhat incorrectly. It would be more correct turned through an angle of 90 deg. showing the least radial wall thickness at the bottom of the diagram, thus conveying more clearly the fact that this effect is due to the influence of gravity. Incidentally, this effect was investigated by Lewicki in 1898 ZVDI. Vol. 42, p. 572, 1898), using oil, benzole and water.

"Semi-Centrifugal Casting"

The term semi-centrifugal casting is not applicable to centrifugal pressure castings. As indicated in the Paper, the latter refers to the production of asymmetrical castings which cannot be spun about their own axis. The former is a classification proposed for those castings not formed by the effect of centrifugal force alone. Some forms of brake drums are examples of this latter classification. I see very little to object to in the permanent acceptance of this term, and surely it cannot be misinterpreted to quite the same extent as the term "semi-steel," which latter, incidentally, has some merits.

With reference to Dr. Lee's suggestion relating to "the true theoretical criterion for centrifugal casting," the facts are that in practice speed conditions are used which provide a minimum internal liquid pressure. These speed conditions and consequently conditions of internal liquid pressure vary for different types of casting, types of mould and also types of alloy and casting process.

The dimensional and metallurgical characteristics of the castings produced are the primary considerations in any centrifugal casting process. These are influenced by other considerations in addition to rotational speed and internal liquid pressure. For this reason a minimum internal pressure cannot be regarded as the sole "theoretical criterion for centrifugal casting." I do think, however, that there is some merit in designing and operating a centrifugal casting process producing a uniform type of casting under conditions of uniform internal liquid pressure.

The misprints in the text to which Dr. Lee has kindly drawn attention will be corrected in the final printing.

NEW PATENTS

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each.

563,866 WESTINGHOUSE ELECTRIC INTERNATIONAL COMPANY. Speed control of multi-drive work units, particularly the stands of a tandem rolling mill.

563,893 LOEWY ENGINEERING COMPANY, LIMITED, and FERNBACH, H. R. Apparatus for measuring the operating speed of a metal extrusion press.

563,970 STERN, M. Method for the production of shaped articles from magnesium and magnesium-alloy scrap.

563,994 NATIONAL SMELTING COMPANY. Aluminium base alloys.

564,012 SHORTER PROCESS COMPANY, LIMITED, and SHORTER, A. E. Method of and means for hardening internal surface portions of metal articles.

564,039 BARRON, C. A., and BARRON, H. D. Drawing drums for wire-drawing machines.

564,046 MOND NICKEL COMPANY, LIMITED. Lubrication of metal articles during drawing.

564,076 FIFE, J. G. (Meehanite Metal Corporation). Apparatus and method for the control of air flow through furnace tuyeres.

564,081 MAGNESIUM ELEKTRON, LIMITED, FOX, F. A., and WILKINSON, R. G. Magnesium base alloys.

564,095 BRASSERT & COMPANY, LIMITED, H. A., and NISSIM, R. Open-hearth furnaces.

564,201 BAINES & COMPANY, LIMITED, C. J., and MCCALLA, B. A. Manufacture of ferro-alloy briquettes for use in the production of high-duty cast iron.

564,208 WELLMAN SMITH OWEN ENGINEERING CORPORATION, LIMITED, and NEWMAN, F. S. Apparatus for stripping ingots from moulds.

564,213 WILSON WELDER & METALS COMPANY, INC. Welding transformers.

RICHARD THOMAS AND BALDWINS

FUSION PROPOSED

A fusion of the undertakings of Richard Thomas & Company, Limited, and Baldwins, Limited, is to take place. The directors of the two companies announce that provisional heads of agreement have been signed, under which Baldwins, Limited, will transfer to Richard Thomas & Company, Limited, as from January 1, 1945, its fixed assets, including its steel, sheet, and tinplate businesses, its businesses of manufacture of aluminium sheets and sections, alloy steels, steel tanks, cisterns, etc., and its colliery undertakings together with the goodwill, its stocks, and work in progress. In exchange Richard Thomas & Company, Limited, will allot to Baldwins, Limited, ordinary shares ranking for dividend from January 1, 1945. Coincident with this transaction, steps will be taken to repay the prior lien debenture stock of Richard Thomas & Company, Limited, thus leading automatically to the ending of "control" by July, 1945. (Under arrangements made in July, 1938, Richard Thomas & Company is to be under the control of a committee (consisting of the Governor of the Bank of England, the chairman of the company, a representative of the steel industry, and a nominee of the trustees for debenture holders) for seven years from July, 1938, or until the redemption of the prior lien debenture stock, whichever is longer.)

The agreement is subject to the approval of the shareholders, to all other necessary consents being obtained, and other legal formalities.

Arrangements will be made whereby Richard Thomas & Company, Limited, will take over all staff and workpeople employed by Baldwins, Limited, as at December 31, 1944. It is proposed to change the name of Richard Thomas & Company, Limited, to Richard Thomas & Baldwins, Limited, and the name of Baldwins, Limited, to Baldwins (Holdings), Limited.

After the fusion, both companies will work in the closest collaboration in respect of the proposed modernisation of the tinplate and sheet industries in South Wales in conjunction with other companies interested in these trades, and will assist such developments to the fullest possible extent financially.

PERSONAL

DR. H. R. RICARDO, president of the Institution of Mechanical Engineers, has been awarded the Rumford Medal of the Royal Society, in recognition of his important contributions to research on the internal combustion engine.

MR. W. L. E. SHORT, who has been manager of the Dumbarton works of Babcock & Wilcox, Limited, since 1915, will retire at the end of this year. MR. W. P. ROSS, at present assistant manager, has been appointed manager as from January 1 next.

NEWS IN BRIEF

MULTIMETALS, LIMITED, is being wound up voluntarily. Mr. W. J. Watt, 20, Essex Street, London, W.C.2, is the liquidator.

THE GENERAL CABLE MANUFACTURING COMPANY, LIMITED, proposes to increase the capital from £150,000 to £250,000 by creating 400,000 additional 5s. ordinary shares.

THE DIRECTORS of the South African Torbanite Mining Company, Limited, are offering 891,250 5s. shares at par in the proportion of one for every two held. Proceeds of the issue are required to finance a programme of development.

CHRISTMAS PRESENTS IN KIND given by an employer to his subordinate employees are not treated as taxable remuneration, and this treatment has been extended to the presentation of Savings Certificates or Savings Stamps in lieu of such presents.

MR. HUGH DALTON, President of the Board of Trade, said in London recently that it was a blunder to think that there were large reserves of men and materials which were now able to be released from the war effort to increase our home and export trade or to raise the standard of civilian consumption at home.

WORKERS who have been under direction away from home for three years or more are being put by the Ministry of Labour in a priority class in order that they may be able to return to their homes if there is available work in the neighbourhood. The priority will be subject to the qualification that the first discharges will be those of men wanted for the fighting services.

THE FOLLOWING STATEMENT on chrome-ore analysis has been issued by the Government Chemist:—In the table of International Atomic Weights, 1941 ($O=16$) the atomic weight of iron is 55.85, and that of chromium is 52.01. Using these atomic weights the factor for converting a known weight of ferrous iron to its equivalent weight of Cr_2O_3, according to the relationship $6Fe=Cr_2O_3$, is 0.4537; and this is the correct factor to use for this circulation.

A FREIGHT of £2 per ton is stated to have been paid in January, 1943, to the Cunard White Star Liner "Georgic" for bringing pig-iron from Bombay to Britain. An account in the "Shipping World" of how the "Georgic," bombed at Suez in July, 1941, was taken by stages to India for repairs, states: "Before the "Georgic" left Bombay, 5,000 tons of Indian pig-iron were loaded. This ballasted the ship, in addition to earning for her a freight of £10,000."

ADDRESSING THE Incorporated Sales Managers' Association in London, Lord Dudley Gordon declared that he "saw no cause for repining" in the fact that Britain had now become a debtor nation. That fact, he said, took away from us the danger of living entirely in the past on the achievements of our forbears and becoming soft and indolent—causes which led to the downfall of other empires in the past. The only way in which we could pay our debts was that those who had lent us money should accept goods in payment.


DALE
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DALE
The High-Quality Iron for High-Duty Castings.
Made in seven standard grades or to individual requirements, this iron has a close grain structure and fine graphitic carbon content. It replaces Hematite, and tones up high phosphorus irons.
We also make Dale Refined Malleable Iron to any required specification.
STANTON
DALE Refined PIG IRON
THE STANTON IRONWORKS COMPANY LIMITED
NEAR NOTTINGHAM

COMPANY RESULTS

(Figures for previous year in brackets)

Mellowes & Company—Interim dividend of 10% (same).

F. H. Lloyd & Company—Dividend of 3% actual on account of year ended March 31 (same).

Brown, Bayley's Steel Works—Final dividend of 8%, free of tax, making 13%, tax free (same).

Coley Metals—Net dividend income for the year to January 31, 1944, £11,000; dividend of 20%, £10,000; forward, £283.

Paterson Engineering—Net profit for the year ended April 30, 1944, £10,114 (£10,785); dividend of 10% (same) and a bonus of 2½% (same).

Wombwell Foundry & Engineering—Profit to July 31 last, after tax, £10,852 (£9,316); dividend of 16% (same); to taxation reserve, £4,500 (£4,300); forward, £6,407 (£5,254).

R. & W. Hawthorn Leslie—Net profit for the year to June 30, £130,486 (£133,632); dividend of 15%, including a bonus of 5% (same); to general reserve, £50,000; forward, £56,043 (£56,168).

Lightalloys—Trading profit to June 30, 1944, after depreciation and tax, £35,150 (£33,075); E.P.T. recovered, etc., £4,320 (£5,843); to general reserve, £7,500 (£6,000); 25% dividend, £30,000 (same); forward, £5,000 (£5,230).

Samuel Osborn—Profit to July 31 last, after providing for taxation, depreciation, contingencies, etc., £55,163 (£55,916); dividend of 15% (same); to reserve for war contingencies, £25,000 (same); forward, £129,517 (£128,605).

Thompson Bros. (Bilston)—Profit for the year to July 31, 1944, £21,132 (£18,734), after all charges, including E.P.T.; final ordinary dividend of 7½%, making 15% (same), plus a bonus of 7½% (same); to general reserve, £10,000 (same); forward, £15,110 (£14,682).

Walter Spencer—Profit to September 30, 1944, £46,733 (£59,153); depreciation, £7,421 (£7,526); net profit, £38,295 (£50,777); taxation, £26,500 (£36,650); dividend of 12½%, £6,250 (same); to reserve, £5,000 (same); war damage, £471 (£589); forward, £24,497 (£24,423).

Frederick Braby—Trading profit for year to September 30, £295,737 (£320,583); tax, £210,000 (£237,000); depreciation, £30,523 (£30,673); net profit, £53,691 (£51,105); ordinary dividend of 10% (same); to suspense reserve, £20,000 (same); forward, £66,700 (£63,234).

Linley Engineering—Trading profit to March 31, £9,852 (£5,475); depreciation, £431 (£453); net profit, £8,622 (£4,372); dividend of 10% and a bonus of 5% (dividend same, bonus 2½%); to taxation reserve, £4,600 (£710), being estimated tax on current profits; to general reserve, £1,500 (£2,750); forward, £3,658 (£2,824).

Mr. Robert Ronceray has written to us from Bonvillain et Ronceray, rue Paul Carle, Choisy Le Roi, Seine, France.

OBITUARY

MR. DANIEL CRAIG died on November 11 at his home at Barrhead, Glasgow, aged 86. He was for 41 years foundry manager of Shanks & Company, Limited.

MR. JOSEPH WILLIAM DOUGHTY, managing director of the Moston Malleable Castings Company, Limited, died on November 16 at his home at Moston, Manchester. He was 84.

STAFF-SERGT. W. K. GREENSMITH, R.A.O.C., who has died as the result of an accident in Northern Ireland, entered the laboratories of the British Cast Iron Research Association as an apprentice in 1936. He joined the Army in 1939.

MR. CHARLES ROBBIE TEVENDALE died recently at his home at Uddingston, Glasgow. A native of Bellshill, Mr. Tevendale went to Motherwell early in life, where he entered the drawing office of Alexander Findlay & Company, Limited, Parkneuk Engineering and Bridge Works. He was associated with the firm for many years as technical manager. Latterly he was on the staff of the Motherwell Bridge & Engineering Company, Limited.

FLIGHT-LIEUT. LLEWELLYN TANNER has died on active service. As a member of Cox & Danks, Limited, Swansea branch, he joined the R.A.F. and was posted to Canada, where for a considerable period he acted as a flying instructor. His exceptional ability earned him a letter of commendation from his Majesty the King. Early this year he returned to this country, when, at his own request, he was posted to Bomber Command. Early this month he took part in an air attack on Germany. His aircraft was badly damaged and, although he succeeded in bringing it back to this country, he was forced to make a crash landing.

NEW COMPANIES

(" Limited " is understood. Figures indicate capital. Names are of directors unless otherwise stated. Information compiled by Jordan & Sons, 116, Chancery Lane, London, W.C.2.)

" Metspray " Engineering Company, 184-190, Blackfen Road, Sidcup, Kent—£100. F. Brown and P. Currie.

Wade & McGrath, North Bridge Pattern Works, Halifax—Pattern makers, etc. £1,000. R. D. Weatherall.

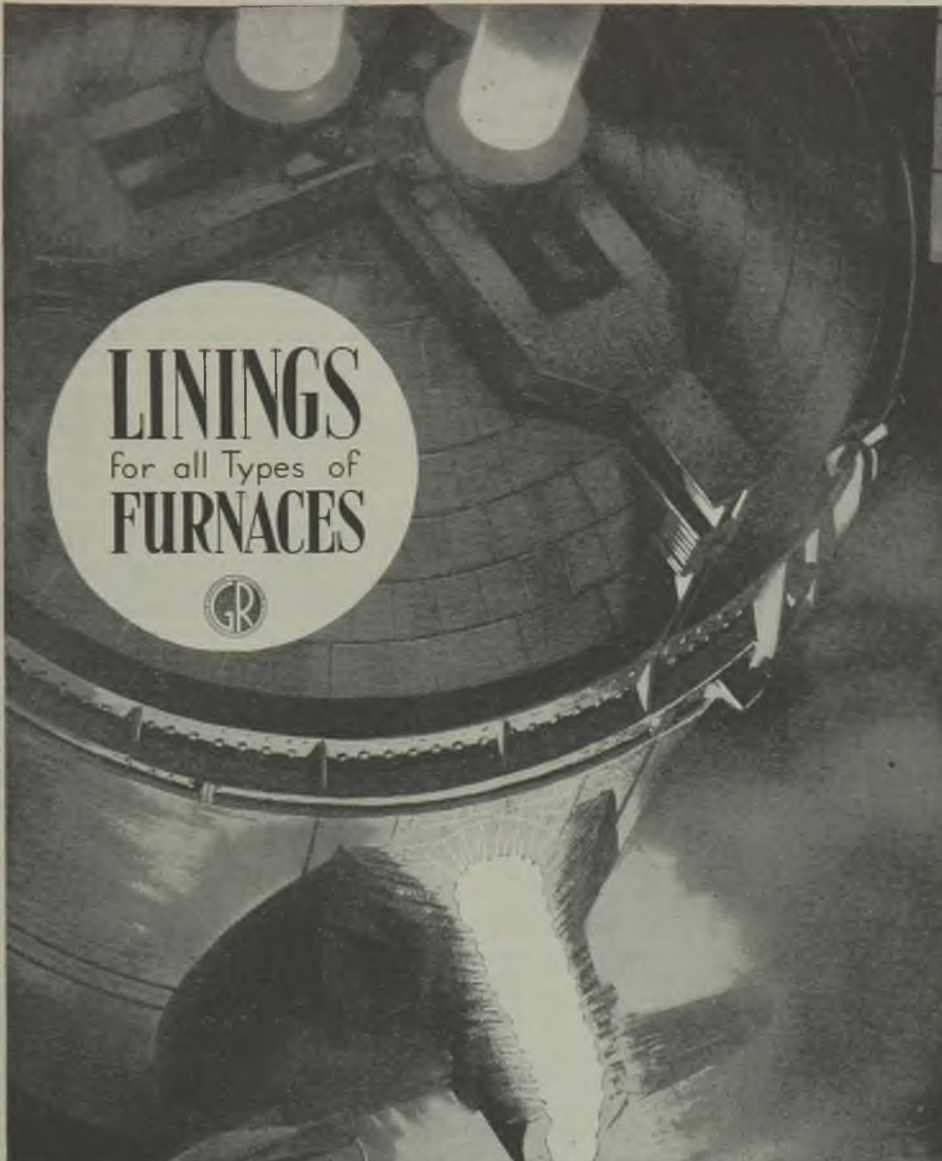
Montgomerie Reid Engineering Company, Baker's Farm, Bramley, Hants—£5,000. J. M. Reid and P. Tomlinson.

Dennis W. Warr, 240, Stratford Road, Shirley, Birmingham—Engineers, etc. £1,000. M. Warr and A. H. Green.

Pantak, Broom Close Works, London Road, Slough—Engineers, etc. £1,000. G. Boothman and M. J. Mackenzie.

Manor (London)—Engineers, etc. £10,000. D. J. Chandris, 46, Upper Grosvenor Street, London, W.1, and W. H. Powell.

Clark Bros. (Wolverhampton), Cable Street, Wolverhampton—Metal spinners and engineers. £10,000. O. H. and M. Clark.


LININGS
for all Types of
FURNACES
GR

Raw Material Markets

IRON AND STEEL

Recent experience would seem to vindicate the policy of the Cartel in limiting the issue of licences. Foundries are still able to secure sufficient iron for current needs, but the improvement in the employment position at the light-castings establishments has already disturbed the balance between production and consumption. The fuel position precludes the relighting of additional blast furnaces and any substantial increase in the demand for iron could only be met by drawing upon stocks. Output of basic iron is adequate for steelworks' needs, and refined iron for use in place of hematite is moving steadily into consumption. It is, however, thought probable that the make of hematite will be increased next month.

The foundries are now having little difficulty in regard to supplies of scrap. There have been some signs of an increase in the demand for the heavier grades of scrap, but the lighter varieties are quiet.

It is expected that definite tonnages of coke will shortly be allocated to individual consumers, but the scheme has not yet been got into full working order. Supplies have tightened up a little recently, but before then coke was plentiful and foundries with stocking accommodation have had ample time to lay in reserves.

Maximum deliveries of all classes of semi-finished steel are still called for and, as the re-rollers will be fully engaged to the end of the year, no slackening in the call for material is anticipated during that period. Indeed, there is a shortage of the smaller billets, and re-rollers are freely taking up any defectives which may come on offer.

During the past week or two, specifications for steel plates have been released rather more freely, but the tempo of operations at the shipyards is still on a reduced scale, and, as a consequence, plate rollers are keenly seeking orders in other directions. Revival of the demand for heavy structural steel is also probably deferred until the reconstruction period, but the light and medium sizes are in steady request. The sheet mills, too, are assured of regular employment for two or three months ahead, and a much larger proportion of the output is being galvanised. Some of the collieries have been allotted big quotas of steel, and works are turning out good tonnages of arches, roofing bars and props as well as steel rails and chairs.

NON-FERROUS METALS

Conditions in the non-ferrous metals market show little change. Consumption of copper is still registering a gradual decline. Materials for the war effort are no longer required in such large quantities as they were at the peak demand period some two years ago, and the amount of civilian work allowed to be undertaken does not so far make up for this decrease. Even the limited scale of civilian manufacture now being undertaken is only on condition that there is sufficient labour available—and some works are down to below pre-war labour strength. The copper-producing countries are generally reducing their outputs. The Canadian monthly output of copper is stated to be lower now than at any time since the beginning of the war. Here again the labour shortage is said to be the main factor in the reduction.

The tin supplies at the disposal of the United Nations are quite adequate for week-to-week consumption, and there are believed to be reasonably good stocks in hand, but the use of the metal still has to be strictly controlled. Production in Nigeria and Bolivia has been quite well maintained, but the position will not be completely assured until supplies are once more available from the Far East.

Reports from the United States have indicated that the lead supply situation there has become tighter. Man-power shortage has led to a steady decline in domestic output, while production in Mexico has also fallen. It may be found necessary to tighten up the restrictions on the use of lead in America. In this country the supply situation is not difficult, but a fairly stringent allocation policy continues to be followed.

Following the deferment of United States orders for Canadian aluminium, it is announced that British orders have also been curtailed. It is stated by the Aluminium Company of Canada that these latest reductions will cut down output by more than one-half.

A JOINT MEETING of the Iron and Steel Institute and the Sheffield Branch of the Institute of British Foundrymen will be held on November 27 at the Royal Victoria Hotel, Sheffield, at 7 p.m., when a Paper by Mr. B. Gray, entitled "The Side Feeding of Steel Castings—A Note on the Influence of the Mechanism of Freezing," will be discussed. Members of the Sheffield Society of Engineers and Metallurgists and of the Sheffield Metallurgical Association are invited to attend and take part in the discussion.

CURRENT PRICES OF IRON, STEEL AND NON-FERROUS METALS

(Delivered, unless otherwise stated)

Wednesday, November 22, 1944

PIG-IRON

Foundry Iron.—CLEVELAND No. 3: Middlesbrough, 128s.; Birmingham, 130s.; Falkirk, 128s.; Glasgow, 131s.; Manchester, 133s. DERBYSHIRE No. 3: Birmingham, 130s.; Manchester, 133s.; Sheffield, 127s. 6d. NORTHANTS No. 3: Birmingham, 127s. 6d.; Manchester, 131s. 6d. STAFFS No. 3: Birmingham, 130s.; Manchester, 133s. LINCOLNSHIRE No. 3: Sheffield, 127s. 6d.; Birmingham, 130s.

(*No. 1 foundry 3s. above No. 3. No. 4 forge 1s. below No. 3 for foundries, 3s. below for ironworks.*)

Hematite.—Si up to 3.00 per cent., S & P 0.03 to 0.05 per cent.; Scotland, N.-E.Coast and West Coast of England, 138s. 6d.; Sheffield, 144s.; Birmingham, 150s.; Wales (Welsh iron), 134s. East Coast No. 3 at Birmingham, 149s.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, 140s. 6d., delivered Birmingham.

Scotch Iron.—No. 3 foundry, 124s. 9d.; No. 1 foundry, 127s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, 174s.; South Zone, 176s. 6d.

Refined Malleable.—North Zone, 184s.; South Zone, 186s. 6d.

Cold Blast.—South Staffs, 227s. 6d.

(NOTE.—*Prices of hematite pig-iron, and of foundry and forge iron with a phosphoric content of not less than* 0.75 *per cent., are subject to a rebate of 5s. per ton.*)

FERRO-ALLOYS

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

Ferro-silicon (5-ton lots).—25 per cent., £21 5s.; 45 per cent., £25 10s.; 75 per cent., £39 10s. Briquettes, £30 per ton.

Ferro-vanadium.—35/50 per cent., 15s. 6d. per lb. of V.

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

Ferro-titanium.—20/25 per cent., carbon-free, 1s. 3½d. lb.

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

Tungsten Metal Powder.—98/99 per cent., 9s. 9½d. lb.

Ferro-chrome.—4/8 per cent. C, £46 10s.; max. 2 per cent. C, 1s. 3¾d. lb.; max. 1 per cent. C, 1s. 4¼d. lb.; max. 0.5 per cent. C, 1s. 6d. lb.

Cobalt.—98/99 per cent., 8s. 9d. lb.

Metallic Chromium.—96/98 per cent., 4s. 9d. lb.

Ferro-manganese.—78/98 per cent., £18 10s.

Metallic Manganese.—94/96 per cent., carb.-free, 1s. 9d. lb.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.—BASIC: Soft, u.t., 100-ton lots, £12 5s.; tested, up to 0.25 per cent. C, £12 10s.; hard (0.42 to 0.60 per cent. C), £13 17s. 6d.; silico-manganese, £17 5s., free-cutting, £14 10s. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £15 15s.; case-hardening, £16 12s. 6d.; silico-manganese, £17 5s.

Billets, Blooms and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £13 17s. 6d.; basic hard, 0.42 to 0.60 per cent. C, £14 10s.; acid, up to 0.25 per cent. C, £16 5s.

Sheet and Tinplate Bars.—£1[illegible] 2s. 6d. 6-ton lots.

FINISHED STEEL

[*A rebate of 15s. per ton for steel bars, sections, plates, joists and hoops is obtainable in the home trade under certain conditions.*]

Plates and Sections.—Plates, ship (N.-E. Coast), £16 3s.; boiler plates (N.-E. Coast), £17 0s. 6d.; chequer plates (N.-E. Coast), £17 13s.; angles, over 4 un. ins., £15 8s.; tees, over 4 un. ins., £16 8s.; joists, 3 in. × 3 in. and up, £15 8s.

Bars, Sheets, etc.—Rounds and squares, 3 in. to 5½ in., £16 18s.; rounds, under 3 in. to ⅝ in. (untested), £17 12s.; flats, over 5 in. wide, £15 13s.; flats, 5 in. wide and under, £17 12s.; rails, heavy, f.o.t., £14 10s. 6d.; hoops, £18 7s.; black sheets, 24 g. (4-ton lots), £22 15s.; galvanised corrugated sheets (4-ton lots), £26 2s. 6d.; galvanised fencing wire, 8 g. plain, £26 17s. 6d.

Tinplates.—I.C. cokes, 20 × 14 per box, 29s. 9d. f.o.t. makers' works, 30s. 9d., f.o.b.; C.W., 20×14, 27s. 9d., f.o.t., 28s. 6d., f.o.b.

NON-FERROUS METALS

Copper.—Electrolytic, £62; high-grade fire-refined, £61 10s.; fire-refined of not less than 99.7 per cent., £61; ditto, 99.2 per cent., £60 10s.; black hot-rolled wire rods, £65 15s.

Tin.—99 to under 99.75 per cent., £300; 99.75 to under 99.9 per cent., £301 10s.; min. 99.9 per cent., £303 10s.

Spelter.—G.O.B. (foreign) (duty paid), £25 15s.; ditto (domestic), £26 10s.; "Prime Western," £26 10s.; refined and electrolytic, £27 5s.; not less than 99.99 per cent., £28 15s.

Lead.—Good soft pig-lead (foreign) (duty paid), £25; ditto (Empire and domestic), £25; English, £26 10s.

Zinc Sheets, etc.—Sheets, 10g. and thicker, ex works, £37 12s. 6d.; rolled zinc (boiler plates), ex works, £35 12s. 6d.; zinc oxide (Red Seal), d/d buyers' premises, £30 10s.

Other Metals.—Aluminium, ingots, £110; antimony, English, 99 per cent., £120; quicksilver, ex warehouse, £68 10s. to £69 15s.; nickel, £190 to £195.

Brass.—Solid-drawn tubes, 14d. per lb.; brazed tubes, 16s.; rods, drawn, 11⅜d.; rods, extruded or rolled, 9d.; sheets to 10 w.g., 11⅛d.; wire, 10⅞d.; rolled metal, 10½d.; yellow metal rods, 9d.

Copper Tubes, etc.—Solid-drawn tubes, 15¼d. per lb.; brazed tubes, 15¼d.; wire, 10d.

Phosphor Bronze.—Strip, 14¼d. per lb.; sheets to 10 w.g.; 15¼d.; wire, 16½d.; rods, 16½d.; tubes, 21½d.; castings, 20d., delivery 3 cwt. free. 10 per cent. phos. cop. £35 above B.S.; 15 per cent. phos. cop. £43 above B.S.; phosphor tin (5 per cent.) £40 above price of English ingots. (C. CLIFFORD & SON, LIMITED.)

Nickel Silver, etc.—Ingots for raising, 10d. to 1s. 4d. per lb.; rolled to 9 in. wide, 1s. 4d. to 1s. 10d.; to 12 in. wide, 1s. 4¼d. to 1s. 10¼d.; to 15 in. wide, 1s. 4½d. to 1s. 10½d.; to 18 in. wide, 1s. 5d. to 1s. 11d.; to 21 in. wide, 1s. 5½d. to 1s. 11½d.; to 25 in. wide, 1s. 6d. to 2s. Ingots for spoons and forks, 10d. to 1s. 6½d. Ingots rolled to spoon size, 1s. 1d. to 1s. 9½d. Wire, round, to 10g., 1s. 7½d. to 2s. 2½d., with extras according to gauge. Special 5ths quality turning rods in straight lengths, 1s. 6½d. upwards.

NON-FERROUS SCRAP

Controlled Maximum Prices.—Bright untinned copper wire, in crucible form or in hanks, £57 10s.; No. 1 copper wire, £57; No. 2 copper wire, £55 10s.; copper firebox plates, cut up, £57 10s.; clean untinned copper, cut up, £56 10s.; braziery copper, £53 10s.; Q.F. process and shell-case brass, 70/30 quality, free from primers, £49; clean fired 303 S.A. cartridge cases, £47; 70/30 turnings, clean and baled, £43; brass swarf, clean, free from iron and commercially dry, £34 10s.; new brass rod ends, 60/40 quality, £38 10s.; hot stampings and fuse metal, 60/40 quality, £38 10s.; Admiralty gunmetal, 88-10-2, containing not more than ½ per cent. lead or 3 per cent. zinc, or less than 9½ per cent. tin, £77, all per ton, ex works.

Returned Process Scrap.—(Issued by the N.F.M.C. as the basis of settlement for returned process scrap, week ended Nov. 18, where buyer and seller have not mutually agreed a price; net, per ton, ex-sellers' works, suitably packed):—

Brass.—S.A.A. webbing, £48 10s.; S.A.A. defective cups and cases, £47 10s.; S.A.A. cut-offs and trimmings, £42 10s.; S.A.A. turnings (loose), £37; S.A.A. turnings (baled), £42 10s.; S.A.A. turnings (masticated), £42; Q.F. webbing, £49; defective Q.F. cups and cases, £49; Q.F. cut-offs, £47 10s.; Q.F. turnings, £38; other 70/30 process and manufacturing scrap, £46 10s.; process and manufacturing scrap containing over 62 per cent. and up to 68 per cent. Cu, £43 10s.; ditto, over 58 per cent. to 62 per cent. Cu, £38 10s.; 85/15 gilding metal webbing, £52 10s.; 85/15 gilding defective cups and envelopes before filling, £50 10s.; cap metal webbing, £54 10s.; 90/10 gilding webbing, £53 10s.; 90/10 gilding defective cups and envelopes before filling, £51 10s.

Cupro Nickel.—80/20 cupro-nickel webbing, £75 10s.; 80/20 defective cups and envelopes before filling, £70 10s.

Nickel Silver.—Process and manufacturing scrap; 10 per cent. nickel, £50; 15 per cent. nickel, £56; 18 per cent. nickel, £60; 20 per cent. nickel, £63.

Copper.—Sheet cuttings and webbing, untinned, £54; shell-band plate scrap, £56 10s.; copper turnings, £48.

IRON AND STEEL SCRAP

(*Delivered free to consumers' works. Plus 3¾ per cent. dealers' remuneration. 50 tons and upwards over three months, 2s. 6d. extra.*)

South Wales.—Short heavy steel, not ex. 24-in. lengths, 82s. to 84s. 6d.; heavy machinery cast iron, 87s.; ordinary heavy cast iron, 82s.; cast-iron railway chairs, 87s.; medium cast iron, 78s. 3d.; light cast iron, 73s. 6d.

Middlesbrough.—Short heavy steel, 79s. 9d. to 82s. 3d.; heavy machinery cast iron, 91s. 9d.; ordinary heavy cast iron, 89s. 3d.; cast-iron railway chairs, 89s. 3d.; medium cast iron, 79s. 6d.; light cast iron, 74s. 6d.

Birmingham District.—Short heavy steel, 74s. 9d. to 77s. 3d.; heavy machinery cast iron, 92s. 3d.; ordinary heavy cast iron, 87s. 6d.; cast-iron railway chairs, 87s. 6d.; medium cast iron, 80s. 3d.; light cast iron, 75s. 3d.

Scotland.—Short heavy steel, 79s. 6d. to 82s.; heavy machinery cast iron, 94s. 3d.; ordinary heavy cast iron, 89s. 3d.; cast-iron railway chairs, 94s. 3d.; medium cast iron, 77s. 3d.; light cast iron, 72s. 3d.

(Note.—*For deliveries of cast-iron scrap free to consumers' works in Scotland, the above prices less 3s. per ton, but plus actual cost of transport or 6s. per ton, whichever is the less.*)

BLAST CLEANING

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MANCHESTER 5

THE SIGN OF
SATISFACTORY SHOTBLAST MACHINERY

MISCELLANEOUS—*contd.*

PATTERNS for Hand or Machine Moulding; sound construction; accuracy; keen quotations; good delivery. —L. E. SLATER, Patternmaker, 267, Coggeshall Road, Braintree, Essex.

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

NORTH-EAST FOUNDRY has capacity for production of repetition Non-ferrous Castings; enquiries welcomed.—Box 736, FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

MISCELLANEOUS—*contd.*

NON-FERROUS FOUNDRY, capacity available, including sand blasting; competitive prices quoted.—ALBUTT, SON & JACKSON, Valve Makers and Brass Founders, Greenmount Works, Halifax.

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

LEATHER APRONS for the Foundry Trade—Made of best quality materials; various types available from 10s. each; 16-page catalogue of Aprons and other lines of industrial clothing and equipment sent post free on receipt of 3d. stamps.—WILLSON BROS., Epsom, Surrey.

CLEAN DRY OAK

WOOD FLOUR

UNGRADED £6-0-0 per ton at works
−100 mesh 45% +100 mesh 17%

GRADED	30/70	mesh	£8-0-0
,,	70/100	,,	£9-0-0
,,	−100	,,	£14-0-0

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THORNTON LANE,
LEICESTER.

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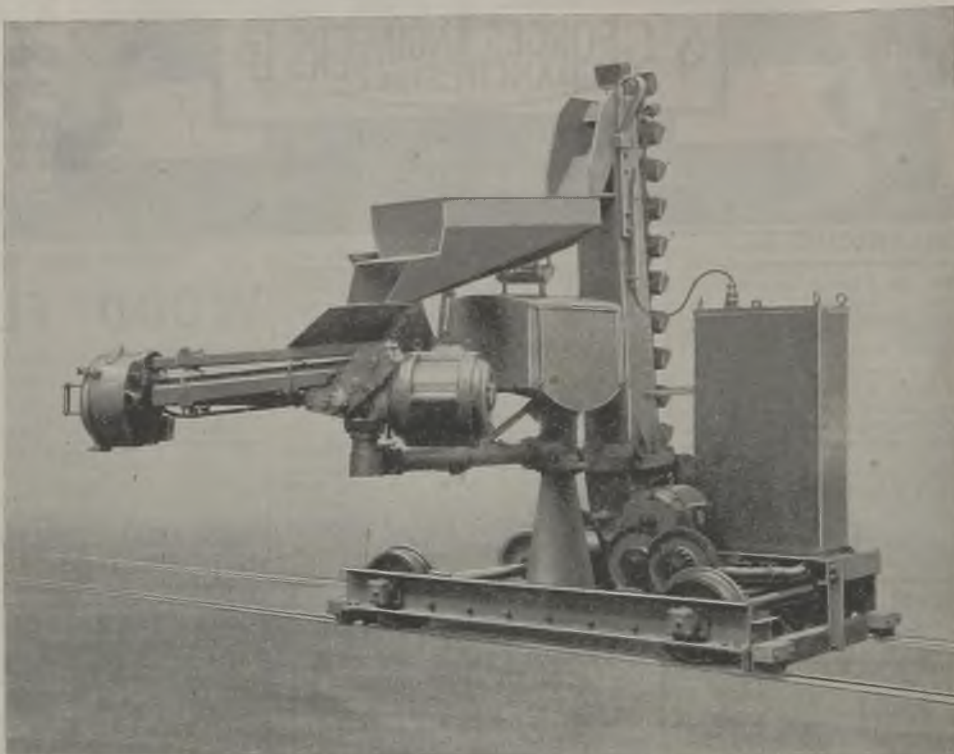

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