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PRINCIPAL CONTENTS

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Practical Examinations

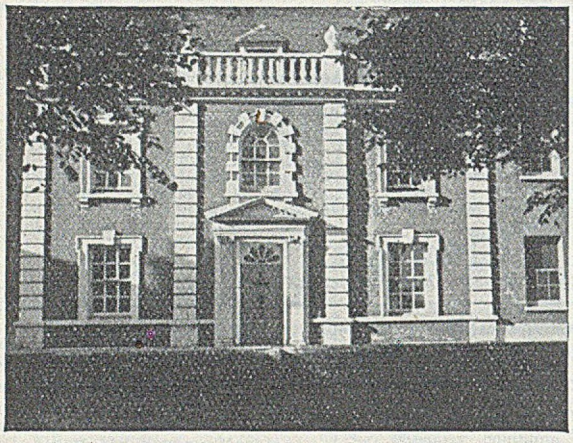
There is growing body of opinion in the foundry industry which favours either the modification of existing examinations so as to favour the more practical type of candidate or perhaps the institution of an entirely new examination specially designed to this end. We think it is not generally realised that it is very difficult for anybody, other than a person possessing a natural gift for descriptive writing, to describe the making of a mould or a complicated core. Quickly, a budding author would want to make short cuts through the use of sketches. This feature is recognised by examining bodies, who cater to the best of their ability to meet this urge by the provision of drawing requisites. Moreover, they stress the importance of drawing and sketching in the framing of the syllabuses. Thus the inclusion of severely practical questions in examination papers does not necessarily help the artisan type of candidate though it may handicap those possessing a superior education.

A separate written examination would not be too helpful, and this poses the question of the desirability of the organisation of national apprenticeship competitions. This is done both in France and the States, and has been tried out in this country also. The last-named effort took place many years ago in connection with a " foundry "—meaning " foundry equipment and supplies "—exhibition held in the Bingley Hall, Birmingham. The winning boy made a nice-looking mould. However, when tested by one of the country's leading foundrymen, it was designated as being of the type which would not turn out a decent casting, as it was ridiculously soft-rammed. Then there is the choice of a pattern from which to mould. With the best will in the world it is bound to favour some lad or lads well-experienced in the line typified, whilst it would handicap others to whom it is quite strange and new. Moreover, in the case of France, the somewhat-extravagant adulation of " the country's best foundry apprentice " is sufficient to give the boy—in the case of this country—such a swelled head that it would convert him into a little prig. Yet that is not to say that this is actually the case in France because the *ésprit* there is quite different from the British.

Yet this demand for practical examination, which is not new, should not be lightly dismissed, and the ultimate solution might be in a series of local rather than national competitions. Not every boy is examination-minded and where works have dropped the insistence of attendance at evening classes, there has been an improved intake of boys. Who is to say that a lad may not be better employed in Boy Scout activities during his evenings than attending the local technical school? Personally we have a quite open mind on the subject, for participation in Scout work does encourage practical exercises and inculcate leadership. We do insist, however, that the examinations organised by the City and Guilds of London Institutes are enjoying ever-increasing popularity, as the number of candidates increases yearly. We have always appreciated to the full the detailed scrutiny which is given by the Committee to the examiners' reports and to the questions to be set in future papers.

John Harper's New Acquisition

As briefly announced in our issue of November 1, John Harper & Company, Limited, of Willenhall, have purchased the St. James Works, Thames Street, Poole, previously operated by Poole Foundry, Limited. Illustrated below are the offices of the new acquisition, architecturally they show an excellent example of the Georgian period. This building will no doubt be carefully conserved by the new owners.



Façade of St. James' Foundry.

Recently, the employees of the St. James' Foundry Works were entertained to dinner by their new principals at the Dolphin Hotel, Poole. Mr. Wilfrid Harper and Mr. H. Field, directors, utilised the occasion to explain the general policy of the Board in the operation of the business. It was disclosed that employees have held shares in the firm since 1924 and by 1950, 50,000 employees' shares had been taken up.

75th Anniversary

As a souvenir of the 75th anniversary of its inauguration, the firm of Matthew Swain, Limited, of Newton Heath, Manchester, 10, has issued an extremely interesting booklet giving both the history of the company and illustrating some of its products. The story opens with the opportunity afforded to the creator, Mr. Matthew Swain, by the shutting down of the Railway Steel & Plant Company, where he had been in charge of the foundry departments. He started business on his own account by building a new works and making the same type of castings in which he was experienced. Soon, however, he changed over to pots and pans, and these lines have been made ever since. The history having been covered, the booklet, wrongly in the reviewer's opinion, switches straight over to illustrating typical products turned out by the firm. He thinks there should have been included a section showing more pictures of the interiors of the shops as they exist today. They would be of real significance when the firm celebrates its centenary or later. The illustrations included do scant justice to what must now be a sizeable concern. The reviewer congratulates the firm on its anniversary and wishes them the success their history warrants in the future.

THE PRICE of antimony ore was reduced by 2s. 6d. per unit on December 5, the new range being 45s. to 50s. nominal per unit, c.i.f.

Dinner

WORSHIPFUL COMPANY OF FOUNDERS

The Worshipful Company of Founders held a livery dinner on December 14 at the Mansion House. The Master (Mr. G. B. Cotton, F.R.G.S., J.P.), had with him at the high table: The Right Hon. the Lord Mayor, Sir Leslie Boyce; Sir Harold Webbe, M.P.; Mr. E. McCarthy; Sir Herbert Williams, M.P.; Alderman Sir George Wilkinson, Bt.; Vice-Admiral T. B. Drew; Alderman Sir Frederick Wells, Bt.; Mr. T. H. Summerson; Mr. Alan Greenaway; Mr. Richard H. M. Thompson, M.P.; Alderman Sir Frederick Rowland, Bt.; Sir F. Handley Page; Mr. Colin Gresty; Mr. W. S. Leuchars; Lt.-Col. O. C. Jones; Dr. G. Roche Lynch; Mr. J. C. Wheeler (past-Master); Sir Leslie Brass; Mr. David A. Thompson; Mr. P. L. Young; Dr. J. S. Sloper; Mr. Frank Woodward; Dr. H. S. Stannus; Mr. Bryant Hobbs; Dr. F. M. Neild; Mr. A. Stanley Young; Alderman and Sheriff D. H. Truscott; Mr. A. L. Parrott; Mayor C. J. Cotterell (Upper Warden); Sheriff C. J. Harman; Mr. J. W. Hervin; Rev. R. B. R. Walker (Under Warden); Lt.-Col. R. J. Cotterell; Rev. W. H. Dormor; Mr. Leslie E. Mullen; Rear-Admiral Sir Arthur Hall, K.B.E., C.B., and Mr. L. C. Dorman.

Amongst those present were:—

Brig.-Gen. Magnus Mowat; Mr. Arnold Carr; Mr. D. Cherry Paterson; Mr. C. H. Kain; Mr. J. F. Stanier; Mr. Norman L. Goodchild; Mr. Kenneth Marshall; Mr. C. C. Booth; Mr. A. P. L. Blaxter; Mr. J. Arthur Taylor; Mr. R. W. Hatswell; Major Sir Paul Booth; Mr. Arnold E. Pearce; Lord Ratheredan; Mr. H. Wilson Wiley; Mr. H. Morrogh; Dr. H. T. Angus; Mr. W. G. Fossick; Mr. G. R. Woodward; Dr. J. G. Pearce; Mr. P. H. Wilson; Sir Ben Lockspeiser; Dr. J. E. Hurst; Mr. D. H. Wood; Mr. F. Arnold Wilson; Mr. Noel P. Newman; Mr. K. A. Adams; Mr. F. W. Rowe; Mr. P. A. Russell; Mr. R. B. Templeton; the Rt. Hon. Viscount Davidson; Mr. R. C. Scott; Mr. V. C. Faulkner; Mr. G. F. Mundell; Mr. F. N. Wright; Mr. J. J. Sheehan; Mr. Wilfrid Harper, and Mr. F. J. R. Miles.

During the evening the company was entertained by Miss Janet Howe (contralto) and Mr. John Myrddin (tenor), with Mr. Clifton Helliwell at the piano.

Long Service Recognised

A dinner was given at the Midland Hotel, Bradford, on December 7, in honour of two men who have given long service to the Bradford engineering firm of Crofts Engineers (Holdings), Limited, one having completed 50 years' service, while the other will complete that period with the firm in January. They were Mr. R. Cockcroft, deputy-chairman and deputy managing director of the firm, who is retiring at the end of the year, and Mr. Arthur Brooke, manager of the heavy machine-shops. Mr. Brooke received a cheque for £50, presented to any member of the firm who completes 50 years' service. Mr. Arthur Croft, chairman of the firm, paying tribute to the work of Mr. Cockcroft, described him as the peacemaker in all sections of the firm, and said that his fair outlook had played a great part in the lack of labour disturbances experienced.

B.I.S.R.A.'s Sheffield Laboratories

Equipment for the new steel research laboratories being built in Hoyle Street, Sheffield, for the British Iron and Steel Research Association, has already begun to arrive and some will probably be installed early next year. The equipment includes a 10-cwt. experimental arc furnace for steel melting and a plastometer for studying the strength of metals at high temperatures.

Precision Casting Methods*

By W. H. Sulzer

The Author deals comprehensively with the method of obtaining precision castings, using a fusible pattern, which is known as "investment casting" or the "lost-wax" process, in which an expendable pattern is removed by melting from the mould constructed around it. Detailed information is given on each stage of the process, and recommendations are made of the choice of materials and technique. A Table is included giving the tensile properties of precision steel castings.

Historical

The method of producing single castings by means of patterns which can be melted out is not a new discovery. As long ago as 1,000 B.C. the Chinese knew the basic principles. Only in the middle ages was this art initiated in Europe, and later during the Renaissance employed on a large scale by Benvenuto Cellini. The procedure as handed down from that time, has remained unchanged to this day for the casting of art work. The great progress made in present-day precision casting methods can be attributed to two recent applications, namely dentistry and castings for jewellery, carried out mainly in the United States as a domestic industry. In the former, since it required the highest degree of accuracy and fineness of surface, melting-out methods increased the accuracy of dimensions attainable. The casting of jewellery, in which the object was to supply as many as possible similar products, requiring not so much extreme accuracy as economic reproduction, solved the problem of mass-producing patterns, and contributed substantially to the application of this method to industry. These three main factors were therefore the starting point for the development of present-day methods, in which the object was to apply precision casting exclusively to the preparation of moulds, to be used once only, by means of patterns which could be melted out. To some extent die-casting, chill-casting and the Croning process and others could be called "precision" casting methods. The underlying differences from the "melting-out" methods justify, however, the use of a new expression which in other countries is described as "*cire-perdue*," "lost-wax," and "investment" casting.

* An abridged version of an article appearing in *Die Neue Giesserei*, **25**, 557-565, translated by the B.S.A. Group Research Centre.

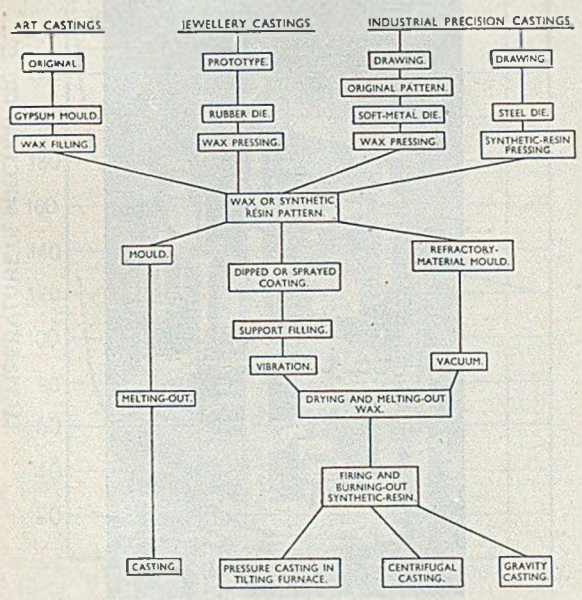


FIG. 1.—*Tabular Comparison of Stages embodied in Precision-casting Methods for Art, Jewellery and Industrial Application.*

The various principles of the method are briefly as follow (see Fig. 1): In a mould or die an exact model is first of all made by injection taking into account dimensional changes in volume during the moulding and casting processes. The material for this pattern must be selected so that it can be melted by raising the temperature and poured out of the mould, without leaving any residue such as ash behind. For this purpose, wax mixed with suitable vegetable and mineral products has proved most efficacious. As far as maintaining the shape and accuracy of dimensions are concerned certain synthetic resins are of course more suitable, since they assure much more accurate and regular castings. When such a pattern is ready and provided with suitable gates and risers a mould must be formed round it, for which various methods, which will be introduced later, are applicable. After the mould has been prepared and the pattern melted out, casting is carried out by gravity casting, by centrifugal casting, or by pressure casting in a small tilting furnace, which for the operation in question holds sufficient melt for a single mould. When this metal has solidified, the mould is broken, followed by the usual processes of removing the gates and risers, cleaning, heat-treatment, etc.

Die Construction

The preparation of the fusible patterns requires dies suitable for mass-production and which satisfy the highest demands of accuracy and surface quality required by the pattern. A casting is never more accurate nor possesses a better surface than the pattern employed to make it; therefore the more accurately the pattern is made, the more accurate will be the resulting casting. Although dies in rubber or lead (Fig. 2) suffice for the preparation

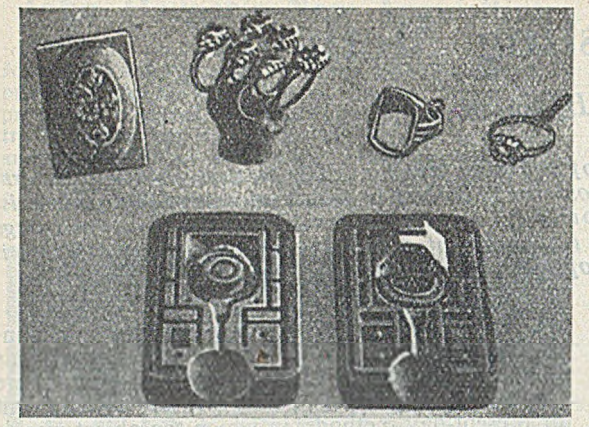


FIG. 2.—*Rubber Dies and Typical Castings obtained by Precision Methods for Jewellery Applications.*

of jewellery or works of art, these are quite out of the question for precision castings, which have to compete with machined products. The best-known method of producing relatively-accurate and not too expensive dies consists in making pressings in a suitable, soft, easily-worked metal from a steel master-pattern, taking into account adjustments in dimensions due to shrinking. Since this method does not require high temperatures and pressures, the material needed for dies of this kind must be an alloy with relatively good cold-working properties. These properties are obtained, for example, with bismuth tin alloy, containing 58 per cent. Bi and 42 per cent. Sn and having a melting point of about 140 deg. C. It is easily seen that with such an alloy, there is danger of damage especially by scratching. Furthermore, the die becomes worn by long use, and it is necessary to make repeated pressings from the master pattern at given intervals. In spite of this, a soft-metal die is particularly suitable in cases where sample castings are required quickly, or where certain technical points in casting or dimensions have to be cleared up before undertaking a large series. Substantially-more-accurate patterns are obtained by the use of steel dies. It is unnecessary to describe their method of preparation here, as it is essentially the normal die-forming process. With steel dies it has also been possible to employ instead of wax a synthetic resin which is appreciably superior in maintaining its shape, and which has a working temperature above the melting point of soft metal. Apart from this, steel dies permit more complicated shapes to be made, such as boring bits and parts with lateral and vertical features and projections, which can be regulated automatically by opening and closing the die. In contrast to soft-metal dies which are rather prone to wear and are easily damaged, steel dies at the temperatures and pressures necessary for synthetic resins are practically free from wear, particularly as the parts normally required are hardened.

Preparation of Patterns

The preparation of synthetic-resin patterns is carried out with the aid of hydraulic presses which are in no way different from the machines used in the resin industry. For wax patterns on the contrary, specially-constructed presses are needed (Fig. 3) employing much lower pressures and temperatures, corresponding to the lower die temperatures for wax against synthetic resins. Nevertheless, the die temperatures must be very accurately controlled on account of the much narrower solidification range. Fig. 4 gives the pressing pressures, on the one hand for a standard wax, and on the other for a low molecular polystyrene specially developed for precision casting. Whether the patterns, according to the construction of the die and the size of the piece, have been pressed either as a single item or as a series, they must have the necessary runners attached so that the whole structure resembles a kind of tree, which serves as a positive pattern for the preparation of the refractory mould (Fig. 5). Assembling is carried out by the use of gas- or electrically-heated tools, the joining of wax, or wax and synthetic resin, components being done be simply melting the wax. An adhesive, on the other hand, is used in cases where it is required to join synthetic resin to synthetic resin. Generally, however, the gates and risers necessary for casting are prepared together with the pattern in the die. Where this is not possible, an auxiliary die must be made. The division of a pattern into two or more parts followed by joining is also done where, due to the complex formation of the part, a much too complicated and costly die would be necessary. Fig. 6 shows on the left a wax pattern made in two parts, which can afterwards be assembled into a single pattern. On the right a casting made from this pattern is shown.

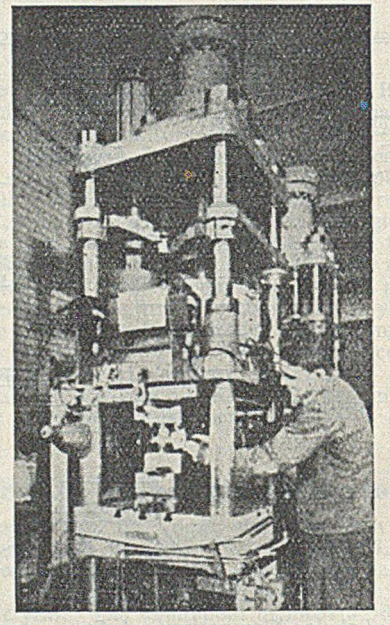


FIG. 3.—*Semi-automatic Press for the Production of Wax Patterns.*

Preparation of the Mould

The next step is the preparation of the mould. Here two distinct methods are employed, namely:—(1) the immersion method, and (2) the simple moulding method (Fig. 7). In the upper diagram, the finished patterns are provided with a very thin refractory coating by dipping them in a liquid mixture of moulding material and binding medium, so that a thin film about 0.5 to 1 mm. thick remains on the surface of the pattern. Immediately after the patterns have been dipped, they are sprinkled with fairly coarse sand (Fig. 8). By this means, the thin film quickly solidifies, and the coating is retained better in the supporting filling material due to the projecting grains. When the coating is dry, the patterns are mounted with a riser underneath on a perforated plate through which the pattern material will later flow, and a cylindrical moulding box of non-scaling sheet is placed over the whole and sealed with wax on to the base plate. The vessel so constructed is now filled with the so-called supporting filling material, a fairly coarse-grained mixture, which is mixed with the binding medium to a thick consistency. The investment is then consolidated on a suitable vibrating table. The coating assumes the role of the moulding sand, guaranteeing the casting a smooth surface, the main filling material supporting the coating when the pattern is melted out. The coating can also be sprayed on.

As a development, it seems likely that the dipped or sprayed coating will be replaced by the so-called "simple moulding" method. In place of the coarse-grained filling material, a fine-grained refractory is used which, on the one hand, must be fine enough to impart a corresponding surface to the casting, but on the other hand, must possess the strength necessary to stand up to the firing and casting processes. This mass, which is so fine as to fill all the hollows and contours of the pattern, always contains some air due to the mixing process, and this is removed under vacuum.

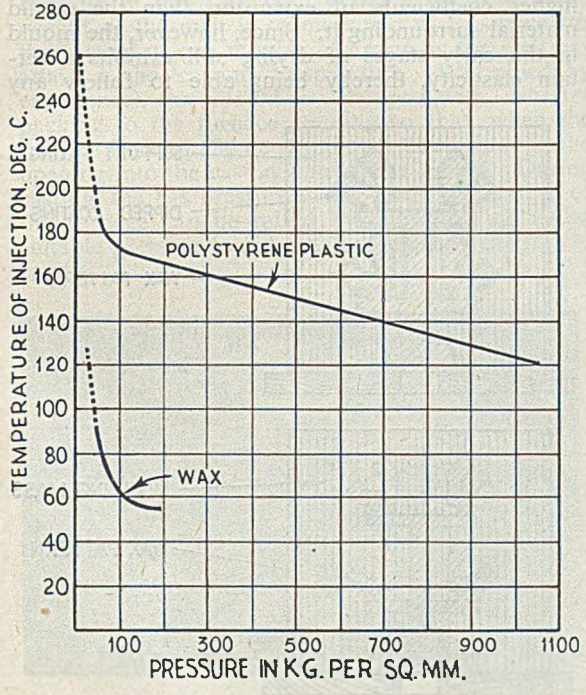


FIG. 4.—*Compacting Pressures and Temperature for Wax and Polystyrene Synthetic-resin Pattern Materials.*

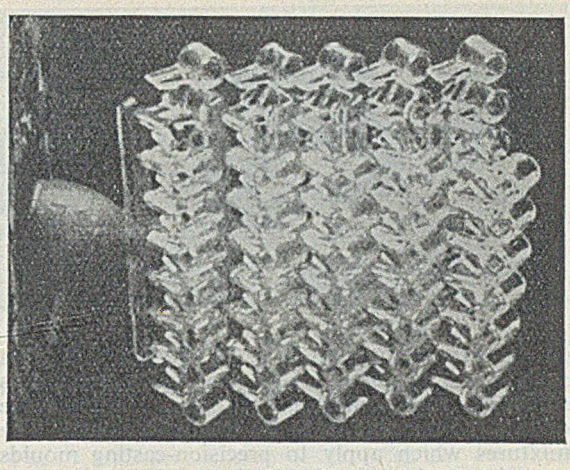


FIG. 5.—*Multiple Patterns Assembled in the form of a "Tree," ready for Investment Moulding.*

Binding Medium

The binding medium plays a decisive part in the preparation of all types of moulds. It must not only be as refractory as the moulding material itself, but is must also be relatively easy to work, and last, but not least, must enable cheap moulds to be made. From the point of view of operating practice, it is obviously of importance whether the binding material cements and hardens in a few minutes or several hours. The binder, morever, must be so constituted that the mould is strong enough to stand up to the forces which arise, for instance, in drying and firing, in the melting out of the pattern or in centrifugal casting. It is understandable that processes occurring in precision casting are greatly restricted by the composition of the mould. Ethyl silicate may be cited as an example of a successfully-developed binding medium. If water is added to tetra-ethyl silicate, depending on the proportion of water, silicate acid or silicon hydroxide and alcohol are formed according to the following equation:

$$SiO_4 (C_2 H_5)_4 + 4H_2O = Si(OH)_4 + 4C_2 H_5 OH.$$

When this reaction takes place in the presence of a powdered refractory material, with simultaneous evaporation of the alcohol formed, the silicate forms a gel-like mass which is deposited on the individual grains of the refractory material. In this manner, as this gel is dehydrated, the mixture attains an increasingly high hardness and strength, the final condition depending on the one hand on the degree of hydrolysis, and therefore on the temperature and presence of catalysts, and on the other hand on the grain-size distribution of the refractory material.

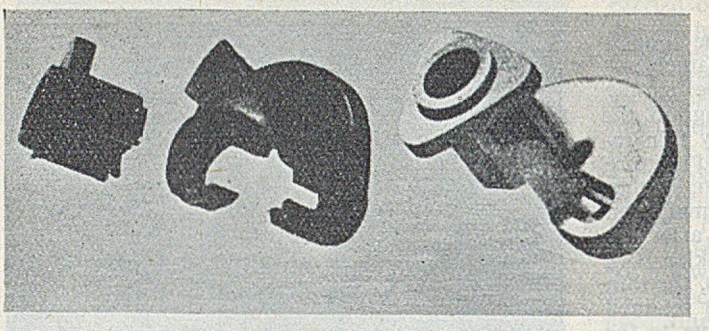


FIG. 6.—*Two-part Wax Pattern (left), ready for Investment Moulding, and the Finished Casting.*

In the ternary diagram (Fig. 9), the line AB gives such a composition, where the water content is sufficient for complete hydrolysis. The curve divides the miscible from the immiscible zone. The mixtures which apply to precision-casting moulds must be to the left of this line and must contain as much ethyl silicate as will result in sufficient strength after the dehydration of the gel. The control of the hydrolising process requires extremely accurate testing and supervision. Only the degree of purity of the moulding material has a decisive influence of the degree of hydrolysis, and thereby in general on the influences of the moulds prepared with this binding medium. Since the use of tetra-ethyl silicate entails a relatively high cost, development work is in progress to find a more economic solution.

Refractoriness

The requirements which must be laid down regarding heat-resistance, depend on the metal used for casting. While a mixture of gypsum and quartz, for example is sufficiently refractory for certain low-melting-point alloys, only the finest raw materials can be used for steel and high-melting-point special alloys, so that there is no danger of forming low-melting-point slags with any of the alloy components. Dry constituents frequently used in the composition of the mould include quartz, alumina, zirconium silicate, zirconium oxide, magnesium oxide, chamotte and sillimanite.

In general, in contrast to normal sand casting, precision-casting moulds are poured while they are hot, *i.e.*, at temperatures between 700 and 1,000 deg. C. This brings into the question problems of calculation in advance for shrinkage and gates and risers. Due to the thermal expansion of the material used in the preparation of the mould, the cavity in the mould grows larger as the temperature increases and with it the size of the casting also. These variations can be readily obtained from the tolerances applicable to precision casting methods, when the temperature of the mould is not accurately maintained. It is therefore also necessary to know the coefficients of linear expansion of the moulding material (Fig. 10).

Heat Dispersion

Since the moulding material acts as an insulator and only a limited amount of heat penetrates each surface unit, heat increases in the mould owing to the additional heat provided by the molten metal being poured in, leading to increased piping, and hindering to a great extent the uniform solidification normally assured as far as possible by the arrangement of the parts, gates and risers. For this reason, complete mastery of the technology of gates and risers is most important, and requires special experience.

Drying and Firing the Moulds

The process of drying and firing the moulds is usually carried out, for technical reasons, in two stages, although it would be possible fundamentally to produce the entire temperature range up to the final temperature in one and the same furnace. In the drying process, the moulds are heated in electric furnaces to a point above the melting point of the wax so that it flows out of the mould. Obviously the strength of the mould must be sufficient to retain the shape given by the pattern. The wax which is melted out can to a great extent be salvaged and after cleaning be used again for the preparation of new patterns. The drying process in which about 60 per cent. of the moisture is removed, must be very carefully supervised. The pattern material in the lower temperature ranges possesses substantially higher coefficients of expansion than the mould material surrounding it. Since, however, the mould in the early stages of drying still exhibits a certain elasticity, thereby being able to follow any

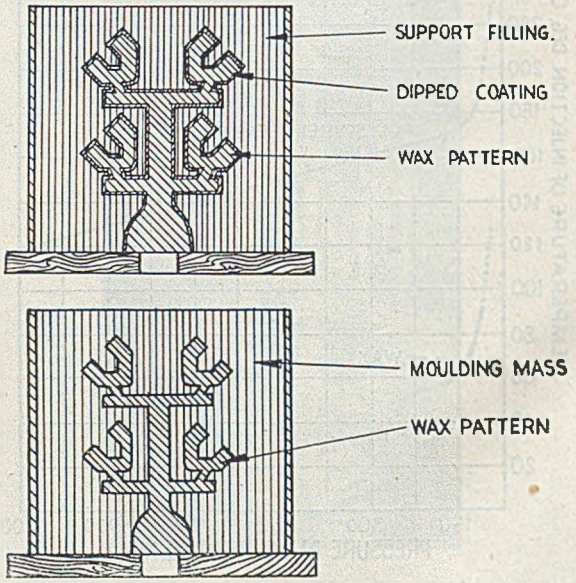


FIG. 7.—*Schematic Comparison of Moulding Methods available for Precision Investment Casting.*

change of shape by the pattern, care must be taken to ensure even and not too abrupt heating by accurately controlling the temperature. Nevertheless, temperature gradients in a mould are unavoidable, and can lead to differences in dimensions, *e.g.*, according to the position of the pattern in the moulding box.

In firing, the temperature of the mould is raised in a well-regulated electric or gas furnace, when the residual wax or synthetic resin also begins to melt and burn with the atmospheric oxygen present in the furnace. Both the time of firing and the temperature must be so arranged that no combustible residue is left in the mould. When the final temperature is reached, which may be as much as 1,000 deg. C., according to the shape of the part, the type of moulding material and the alloy used for casting, the moulds are taken out of the furnace and casting is immediately carried out.

Melting and Casting

The amount of metals used for precision casting are many times smaller than is the case with normal methods of producing castings or forgings. Melting and casting equipment as well as metallurgical considerations must be adapted to suit new requirements.

The great demands on alloys recently developed for industrial precision-casting methods require specially-designed melting equipment and expert metallurgical control of the melting process. The tilting furnace with indirect arcs, expressly supplied for precision casting, is definitely a re-melting apparatus. As regards melting material, ingots or bars of controlled size are normally used. The capacity of this furnace is about 5 to 10 lb. The weight of the melt is so measured as to suffice for the casting of one mould. As soon as the melt has attained the casting temperature (determined by experience), the mould is clamped with asbestos packing to the furnace opening so that, when the furnace is tilted 180 deg., the melt flows through the opening into the casting gate of the mould. During casting, the gas pressure in the melting chamber of the furnace can be raised by admitting air under suitable pressure to aid filling completely the mould cavity.

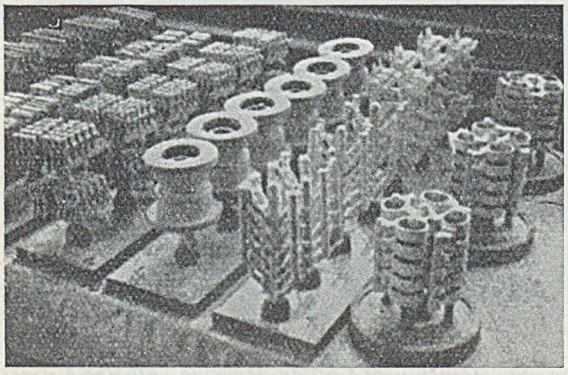


FIG. 8.—*Groups of Patterns mounted on Bases after being Dip Coated prior to Investment.*

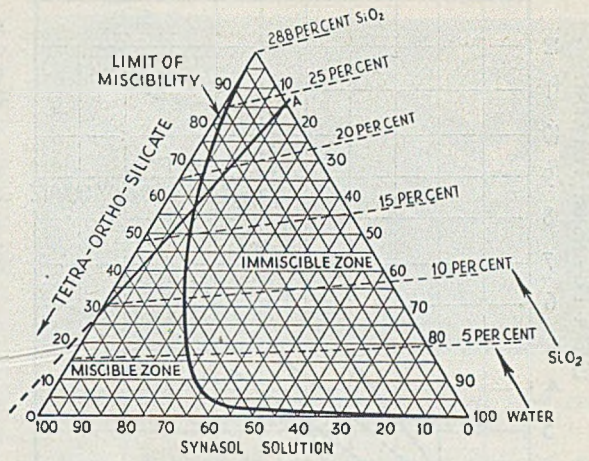


FIG. 9.—*Ternary Constitutional Diagram for Ethyl-silicate, Water and Alcohol showing Miscible and Immiscible Zones.*

For melting larger charges, a rocking-arc furnace is suitable; this gives a uniform melt due to a swinging motion along the axis of the cylindrically-shaped melting chamber. The melt is thus heated by radiation from the graphite electrodes at about 2,000 deg. C. The coreless medium- or high-frequency electric induction furnace is a type which has been found particularly promising in the precision foundry. The mode of working of this furnace is comparable with that of a transformer, the furnace winding representing the primary and the melt the secondary coil. When a medium- or high-frequency alternating current (the frequency is generally determined by the size of the furnace) passes through the hollow, water-cooled copper coil, an alternating electro-magnetic field is generated in the space enclosed by the coil. An electric conductor placed in this field (in this case the charge) is heated by induced currents up to and above its melting point.

Furnace Atmosphere

In the tilting melting furnace, by the reaction between the arc-ing graphite electrodes and oxygen present, an atmosphere of carbon monoxide is produced which protects the molten charge from strong oxidation. This carbon monoxide atmosphere can act as a carburising agent and makes the preparation of alloys which are carbon-free or low in carbon difficult. Disadvantages with regard to maintaining accurately the casting temperature are the inability to regulate the radiated heat and the small capacity of the furnace. Metallurgical control of the melt is either impossible, or can only be carried out with great difficulty.

Metallurgical operations are more easily carried out in the rocking-arc furnace, which can hold a substantially larger charge. Here, also, a carbon-monoxide atmosphere prevents oxidation of the melt. Low-carbon and carbon-free alloys are subject to the same difficulties during melting as in the tilting furnace. The larger charge permits alloys to be made fairly easily, from the pure metals or ferro-

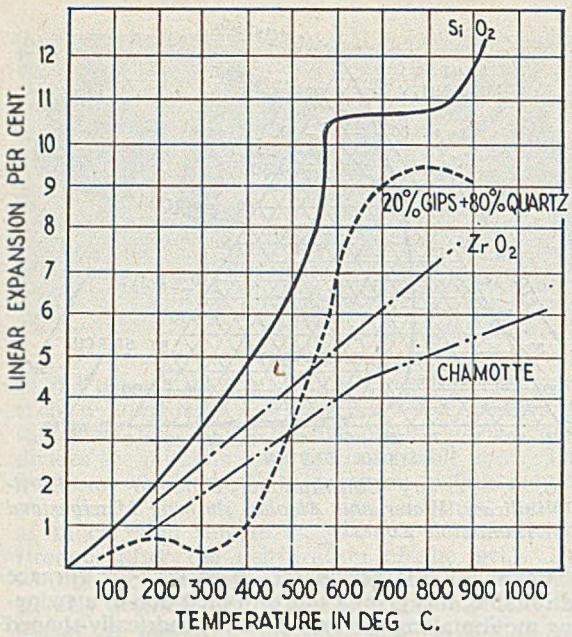


FIG. 10.—*Linear Expansion of Various Moulding Materials in the High-temperature Ranges.*

alloys. Melting bulky scrap is better carried out in the rocking-arc furnace than in the coreless induction furnace, where the filling factor must not be below a certain limit. The rocking-arc furnace favours the solution and uniform mixing of alloying elements in the melts.

Induction Furnace

The coreless induction furnace is very suitable for the preparation of alloys containing high-melting-point metals. Since the induced currents produce a more or less thorough movement in the liquid melt, depending on the frequency and output, pure metals which are only fusible at the very high temperatures, such as tungsten, molybdenum, niobium, and tantalum, can be assimilated in a short time and distributed uniformly throughout the melt. Scrap from the highly-alloyed and carbon-free steels and alloys are easily melted in the induction furnace, and by suitable metallurgical treatment can be converted into high-grade products. The yield can be up to about 98 per cent. of the alloy content. It is thus possible to keep the composition of the finished products within narrow limits, when the make-up of the charge is known. Since it is possible to regulate the input, the temperature of the bath can be accurately adjusted. It is essential to control the melting and casting temperatures to obtain high-grade products with homogeneous properties. Certain heat-resistant alloys, for instance, exhibit different strengths at high temperatures according to the casting temperature. The casting temperature can be accurately recorded and noted with the aid of platinum/rhodium immersion pyrometers.

The coreless induction furnace is suitable for the most varying metallurgical processes such as refining, deoxidation, and desulphurising. The operation permits the necessary slagging-off for certain alloys; it allows the use of finishing slags and also refining slags beforehand. The extent to which operations of this kind can be applied depends upon the steel and alloys to be melted. In many cases, the required mechanical properties and degrees of purity may be successfully obtained by suitable deoxidation of the melt. Various types of alloys can be employed as deoxidising agents, such as silico/manganese, calcium/aluminium, silico/aluminium/titanium, Alsimin, calcium/silicon, etc. The method of working of these alloys is to form with the oxygen in the bath easily fusible droplets of slag, which rise to the surface of the bath with a known velocity according to Stokes' law. The individual alloying elements have a different affinity for oxygen, so that, according to the equilibrium conditions of oxygen dissolved in the bath, they can be reduced to a suitably lower value. The activity of each element rises in the following order: manganese, carbon, silicon, vanadium, titanium, aluminium, zirconium, calcium, magnesium. Aluminium is, for example, one of the most frequently-employed deoxidising agents. If aluminium is added to liquid iron containing oxygen the following exchange takes place:—

$$2Al + 3FeO \rightleftharpoons Al_2O_3 + 3Fe$$

which goes to a great extent towards the right. The equilibrium condition for this transformation is expressed by:—

$$(Al)^2 + (FeO)^3 = K_{AL}$$

From this formula, knowing the temperature relationship of the equilibrium constant K_{AL}, the lowest oxygen content obtainable in the bath for a given temperature can be calculated. Similar relationships are applicable to the other deoxidising elements cited above.

Furnace Linings

Both basic refractory materials (electrically-fused magnesite, electrically-fused magnesia spinel $MgOAl_2O_3$) and acid linings such as silica and

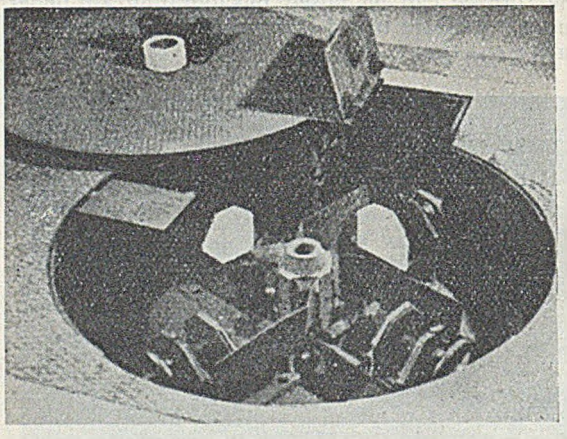


FIG. 11.—*Centrifugal Casting Machine with the Cover removed to show the Radial Disposition of Moulds around a Central Metal-delivery Point.*

zirconium silicate have been found suitable. Thus as a result it is possible in some cases to produce high-quality melts by the acid method. It is well known that the main difference between acid and basic melts is the possibility of a silicon reduction. In contrast to the basic process in which deoxidation reactions result in two liquid phases and a gas phase, the acid process effects deoxidation by carbon reduction by the lining, namely, solid silica. The essential reactions of this Fe-Mn-Si-FeO-MnO-SiO_2 system with respect to carbon can be described by means of the following equations:

(*a*) $Mn + FeO \rightleftharpoons MnO + Fe$
(*b*) $Si + 2FeO \rightleftharpoons SiO_2 + 2Fe$
(*c*) $C + FeO \rightleftharpoons CO + Fe$

All single reactions can be derived from these. Without going in detail into the complete reactions in the acid furnace, the well-known " crucible reaction " for the acid process may finally be quoted:

$$(SiO_2) \text{ solid} + 2(C) \rightarrow (Si) + 2(CO)$$

This determines the silicon reduction in acid steel, and correctly carried out is one of the intrinsic reasons for the quality of crucible steel.

The employment of the tilting furnace avoids the need for special casting equipment. The use of furnaces whose capacity exceeds the volume needed for a single mould enables gravity casting to be employed, if the shape of the castings permits this. Where an increased casting pressure is necessary, the moulds are fastened on centrifugal casting machines which consist of a horizontal rotary table which can take up to four moulds arranged radially (Fig. 11). The liquid metal is poured into a central core port, from which the metal flows by centrifugal force into the mould. According to the speed used, accelerations several times that due to gravity may be obtained. The liquid metal is transferred from the furnaces to the centrifuge by means of pre-heated casting ladles, the contents of which must correspond exactly to the quantity needed for the pouring of the moulds of one centrifuge. Because of the temperature drop of the liquid metal between the moment of tapping the furnace and the time when it flows into the centrifuge, there must be some superheating of the melting bath, the temperature of which is therefore generally kept above that usual in steelworks practice.

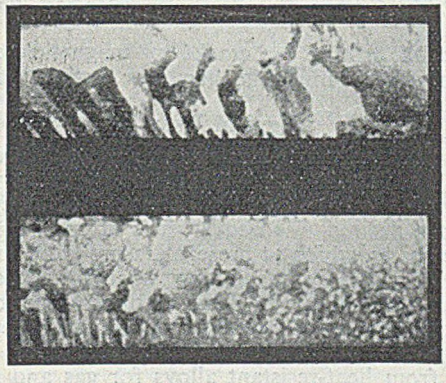


FIG. 12.—*Macrophotographs showing the Influence of Mould Temperature on the Formation of Primary Crystallisation of the Metal. Temperature of Mould (above) 800 deg. C. and (below) 20 deg. C.*

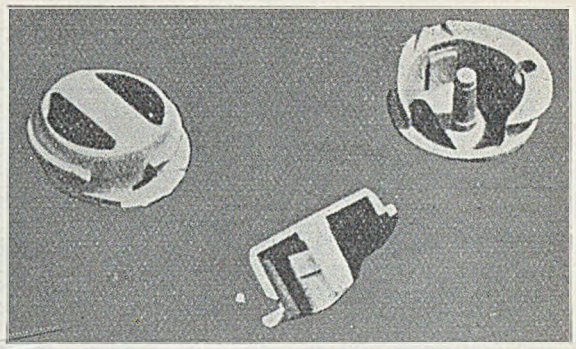


FIG. 13.—*Group of Sewing-machine Components produced by Precision Investment Casting.*

Solidification

The same laws of solidification from the liquid state hold for the cooling of the metal as for other casting processes. The size of the gates and risers are adjusted according to the various casting pressures met with in the casting method being used (centrifugal, tilting or gravity). The properties of cast metals are influenced within fixed limits by the cooling conditions. If the casting be allowed to cool in the hot mould as in precision casting, the rates of cooling are relatively low compared with ordinary castings. This has an important effect on primary crystallisation, especially in alloys which already tend to have too marked a crystalline growth. The variation of the mould temperature may influence the formation of the primary crystals; Fig. 12 shows, for example, the differences in primary crystallisation for a heat-resistant cobalt alloy at different mould temperatures.

Dressing and Control

After the casting has cooled to room temperature, fettling is done by means of suitable apparatus *e.g.* compressed-air hammers, etc. Further cleaning and separation of the castings is done in the usual way by shotblasting, friction discs and band-saws. Precision castings, like wrought or rolled materials, require appropriate heat-treatment if their properties are to be optimum and comparable with those of hot-worked materials. Besides the methods usually employed up to date *i.e.*, quenching and annealing, the heat-treatment can be carried out isothermally, *i.e.*, by " austempering " or " martempering," etc. The latter method has special advantages for precision castings, because variations in the mould due to heat and internal stresses are largely avoided and at the same time very high strength is obtained (Table I).

In hot-worked material, the tensile properties are

TABLE I.—*Tensile Values of Heat-treated Precision-cast Bars.*

Type of steel.	Composition, per cent.				Standard values.				Tensile values of heat-treated precision-cast bars.				
	C.	Cr.	Ni.	Mo.	Yield-point, tons per sq. in.	Max. stress, tons per sq. in.	Yield-point, ratio, per cent. min.	*Elongation, per cent.	Yield-point, tons per sq. in.	Max. stress, tons per sq. in.	Yield-point, ratio, per cent.	Reduction in area, per cent.	†Elongation, per cent.
A	0.11 to 0.18	—	—	—	14.6	26.6	—	28	24.1	23.3	74	73.6	27.3
B	0.10 to 0.17	0.75	3.5	—	41.2	53.9 to 76.0	75	16.9	40.9	54.0	74	50.7	15.2
C	0.13 to 0.17	1.0 to 1.3	—	0.2 to 0.3	44.4	53.9 to 68.9	70	16—10	61.7	72.0	86	54.4	13.0
D	0.27 to 0.35	0.75	3.5	—	44.4	57.1 to 66.6	75	16—10	57.5	65.5	88	44.0	14.6
E	0.15	1.0	—	1.0	34.9	47.6 to 53.9	70	16	49.8	54.6	92	62.5	17.0
					47.6	53.9 to 63.5		15					
F	0.1 max.	18	8	—	13.0	34.9 to 44.4	—	45	16.0	33.8	48	61.3	45.4
G	0.2 (app.)	13.0 to 15.0	—	—	25.3	41.2 to 46.7	—	12 min.	37.8	45.5	83	53.9	17.8

* Length over which elongation is assessed is ten times the bar diameter. † Elongation on five times bar diameter.

A—Unalloyed case-hardening steel, St. C. 16.61, normalised.
B—Cr/Ni case-hardening steel, hardened and tempered.
C—Cr/Mo case-hardening steel, D.I.N. ECMo 80, hardened and tempered.
D—Cr/Ni heat-treatable steel, D.I.N. VCN 35h, hardened and tempered.
E—Cr/Mo heat-treatable steel, hardened and tempered.
F—18-8 Cr/Ni steel, heat-treated.
G—13 per cent. Cr steel, low carbon, heat-treated.

in general higher in the longitudinal direction and lower in the transverse direction while in precision castings they are practically independent of the direction of testing. By the selection of good-quality raw material, the use of suitable melting, casting and heat-treatment equipment, and by the careful control of metallurgical conditions, it is possible, in precision castings as in wrought material, to achieve specified standard test-values for materials tested in the longitudinal direction (Table I).

Special Treatments

Modern heat-treatment methods require a corresponding knowledge of structural transformations (TTT diagram). The curves for isothermal transformation reactions and for continuous cooling need to be drawn from each individual material for which they have not yet been determined, and there is need for extensive investigation. The non-transformable steels and alloys (austenitic chromium-nickel steels, heat-resistant materials, etc.) are subjected to special heat-treatment, *e.g.* solution-treatment, age-hardening, etc., according to the use for which they are intended. Before delivery, the separate parts undergo a detailed test, which, depending on the type of product and the demands on it, may include testing of dimensions, X-ray inspection, testing for cracks by magnetic powder or fluorescent methods, hardness testing, etc.

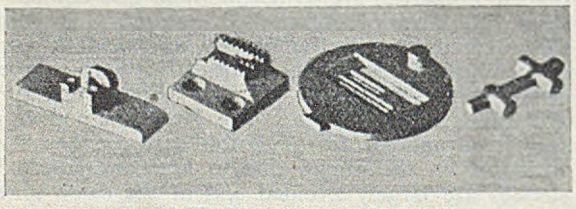


FIG. 14.—*Selection of Parts for Sewing Machines made by Investment Casting.*

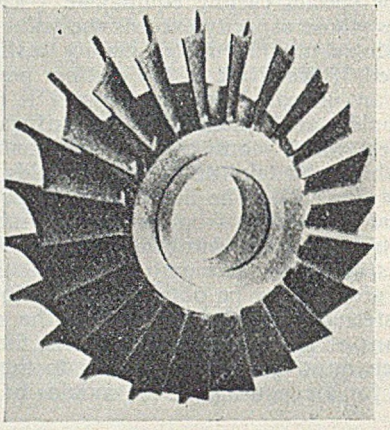


FIG. 15.—*Turbine Rotor with Precision-cast Blades.*

Typical Uses

Precision castings prove especially suitable and economical in cases where metallic materials which are not malleable or cannot be machined by cutting tools are desired. Moreover, it is often cheaper to replace parts, which at present are produced at considerable cost by machining wrought, rolled or pressed material, by precision castings. The following examples served to show in what cases precision casting can be employed with advantage: parts made from heat-resistant alloys for gas and steam turbines such as blades, nozzles, runners, tube-pieces, etc. stainless and acid-resistant fittings for the chemical industry; stainless watch-cases; wear-resistant components for machines of all kinds, *e.g.* shot-blast nozzles; tools, cutters, drills and reamers

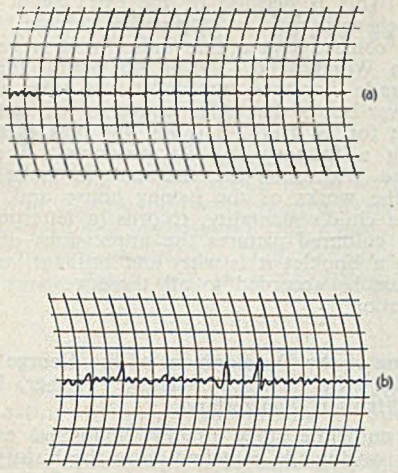


FIG. 16.—*Comparisons of Surface Finish on Castings;* (a) *Precision-cast part, as cast R.M.S.* = 37 *to* 38μ *max. profile height* 10μ; (b) *Precision-cast part after coarse shot-blasting R.M.S.* = 75μ *max. profile height,* 25μ.

of high-speed steel and parts on which a great deal of mechanical wear is to the expected, *e.g.* sewing-machine and textile-machinery components, parts for instruments, arms, machine-tools, etc. Figs. 13 and 14 show sewing-machine components produced as typical precision castings. Fig. 15 shows a turbine rotor equipped with cast blades.

Any metals and alloys which can be cast may be used for precision casting. In particular, besides the usual cast-iron and non-ferrous alloys, all current cast steels, heat-resistant and low-alloy steels, case-hardening and heat-treatable steels, and corrosion-resistant alloys can be used. The accuracy of parts produced by precision casting according to size is to within 0.1 mm. (5 thousandths of an inch), so that a large part of the machining is no longer necessary. The use of specially-prepared mould compositions makes the surface of the casting extremely fine, the average surface roughness is R.M.S. = 60 to 100, corresponding to 0.0015 to 0.0025 mm. (Fig. 16).

Because of the methods involved in manufacture and since comparatively expensive moulds are required, precision casting is especially suited to the manufacture of mass-produced articles. It is similar in this respect to die-casting. The casting of single pieces, *e.g.* dies, moulds, and tools, without having to make expensive steel patterns, is still in the course of development. On the whole, it is clear that precision casting at present is only in its infancy and will certainly lead in the near future to new and interesting fields of application.

BIBLIOGRAPHY

E. L. Cady, "Precision Investment Castings," Reinhold Publishing Corporation, 330, West Forty-Second Street, New York 18.
C. Shaw, FOUNDRY TRADE JOURNAL, 1940, January 10.
J. W. Glaser, *Iron Age,* 1945, 155 (6), 52-57.

FOUR MEN WERE INJURED by an explosion during an experiment into methods of breaking slag at a melting shop of Steel, Peech & Tozer branch of the United Steel Companies, Limited, Rotherham.

U.K. Exports Record in November

United Kingdom exports in November (which contained the normal 26 working days) amounted to £243,800,000, an increase of £8,600,000 over the record total for October (a month of 27 days). In the first 11 months of the year exports were at an annual rate of £2,591,300,000, 19 per cent. above the total for 1950.

The value of imports was £328,800,000, compared with an average of £327,800,000 in January-October. In the first 11 months of the year the value of imports was at a rate of 51 per cent. above the 1950 average. Re-exports in November were £10,100,000, and the excess of imports (valued c.i.f.) over exports and re-exports (valued f.o.b.) in January-November was £1,113,000,000, against £356,000,000 in the year 1950 as a whole.

Exports to the United States in November were valued at £10,100,000, a fall of £1,800,000 compared with October and 14 per cent. below the average for January-September. Exports to Canada—£11,300,000—were £1,000,000 more than in October, but 6 per cent. less than the average for the first nine months of the year. Exports to North America as a whole in November amounted to £21,400,000, a decrease of £800,000 compared with October and 10 per cent. less than the January-September average.

New B.S. for Copper Analysis

A new British Standard for methods for the analysis of raw copper (B.S. 1800:1951) has been announced by the British Standards Institution. It includes methods of analysis (sampling, apparatus, reagents, and procedure) for the elements (except oxygen) for which definite limits are specified in B.S. 1035-40, "Raw copper," and B.S. 1172-74, "Deoxidised and arsenical coppers." A method for the determination of sulphur is also included, although limits are not specified in the above standards.

The methods have been found to give reliable and reproducible results and, while in some instances they may appear to be lengthy, it should be realised that they are intended to be "referee" methods to be used in cases of dispute. Each method is distinct and is designated by a separate part number.

Copies of this standard may be obtained from the British Standards Institution, Sales Department, 24, Victoria Street, London, S.W.1, price 5s., post free.

Scrap Drive to be Intensified

In view of the gravity of the steel scrap situation, the Ministry of Supply, the steel industry, and the scrap merchants have decided to intensify the scrap drive in 1952. Discussions have taken place between the Minister, officials of the scrap drive organisation of the iron and steel industry, and the president, chairman, and members of the management committee of the National Federation of Scrap Iron, Steel, and Metal Merchants. They are investigating ways and means of making even more effective the wide-scale drive which has been undertaken since the beginning of this year by the iron and steel industry in collaboration with the scrap merchants.

The Minister has indicated that he will give full support to measures undertaken by the industry or the scrap merchants to increase scrap supplies.

Publications Received

F.B.I. Register of British Manufacturers 1951-52. 24th Edition. Published for the Federation of British Industries by Kelly's Directories, Limited, 186, Strand, London, W.C.2, and Iliffe & Sons, Limited, Dorset House, Stamford Street, London, S.E.1. Price 42s. (post free).

This edition follows fairly closely in format and contents that which has been established during the last few years. Generally speaking, all well-kept directories are of business interest and this one is particularly so owing to the wide field it covers. It is very well presented and the advertisement section contains some excellent examples of colour printing.

Copper: Its Ores, Mining and Extraction. Published by the Copper Development Association, Kendals Hall, Radlett, Herts.

The reviewer is reasonably sure that only a small percentage of metallurgists is familiar with the subject-matter of this pamphlet, and this gap can be pleasantly remedied by half-an-hour's reading. The booklet, which is well written and nicely illustrated, takes the subject from the actual mining of the various types of ore, right up to the production of pure copper ready for use by the metallurgical industries. Readers wishing to receive a copy can do so by writing to the Association at the above address.

Industrial Accidents, Vol. 8, New Series, 1951. Published for the Factory Department of the Ministry of Labour and National Service by H.M. Stationery Office, Kingsway, London, W.C.2. Price 9d.

The reviewer cordially detests the "dramatic" pictures used in these pamphlets to illustrate accidents. Whilst this type of publicity may be suitable for safety-first posters, it serves no useful purpose in a pamphlet presumably written for executives. The accidents chosen are of outstanding interest and perusal of the booklet is recommended by the reviewer as further accidents may be thereby prevented. It is written in commendably clear English.

The Iron and Steel Trades in 1951. Issued by William Jacks & Company, Limited, Winchester House, Old Broad Street, London, E.C.2.

The time of issuing this annual review has been ill-chosen. Since its preparation there has been a general election which should result in the return of the iron and steel trades to private enterprise. By choosing the month of November, it means that the latest statistics available cover only the first nine months. This well-balanced booklet in general is both excellent and comprehensive, but the reviewer would have liked to see a little more space devoted to the foundry industry, in which the name of Jacks is a household word as a supplier. In the old days, of course, there were no statistics available, but since the war the position has been entirely changed, and in future issues the foundry industry would welcome comment on its achievements or lack thereof.

Alloys in Cooperland. Issued by the Cooper Alloy Foundry Company, Hillside, New Jersey, U.S.A. Price $1.

If one visited the book department of a large stores during the pre-Christmas rush and if this publication found a place in the children's section, it would be outstanding. This is because of the extravagant use of colour such as is used to attract the "kiddies'" attention. Of course, as the title indicates it is based on "Alice in Wonderland." It is no doubt unique in foundry trade literature and whilst it is quite pleasing, the reviewer hopes that other concerns will not try to emulate it for, in truth, it is not the best method of publicising a foundry and its products. The book utilises the Walrus as the character to make a tour through the works of the issuing house and, writing down to a child's mentality, records in letterpress and grotesque coloured pictures the impressions of a layman. As a booklet it is witty and brilliant, and high praise must be accorded to all those responsible for its production.

An Outline of the Development of the George Fischer Works. Published by George Fischer, Limited, Schaffhausen, Switzerland.

Every authentic story of any industrial establishment is a worthwhile contribution to the history of the world, and when presented in the form of a well-illustrated, beautifully bound book written in a good literary style and clearly printed on excellent paper, then and then only can its permanence be guaranteed. Such are the characteristics of this book which has been published as a souvenir of the 150th anniversary of the establishment of the company at Saarbrucken in Switzerland. Now it is quite international with branch works at Singen in Germany and Bedford in England. The firm pioneered the manufacture of steel castings (1888) and malleable iron (1864) on the Continent. Earlier books have dealt with the beginnings of the company and this one, after a brief review of its inception concentrates on the period 1896 to 1946. It tells of the growth, the provision of social services, the overcoming of the shortages during the 1939 war, the entry into the British overseas market through the establishment of the Bedford works and the entry into the light-alloy trade. There is, however, no mention of the firm's entry into the foundry-equipment business.

Working of Aluminium in the Shipyard

Alar Bulletin No. 18 contains practical information which is not only suitable for instructing operatives but will also be found helpful to drawing-office staff. The information is based on the latest practice, but it is important to note that in this field experience is constantly being gained and therefore revision is expected from time to time as the marine uses of aluminium are developed.

The bulk of the publication is divided into four sections, *viz.*, the working of plater's material; sheet-metal work; machining; methods of joining. The last section includes very recent information concerning the development of larger aluminium rivets and driving practice and also information on Argonarc welding in addition to the older methods. Recommendations are given on treatment, where necessary, of aluminium in contact with other metals, with timber and concrete, etc. There are also sections on painting, anti-fouling compositions and deck compositions. There is a brief reference to methods of storing heavy sections and thin material and on the identification of aluminium alloys. Three Appendices deal respectively with (1) aluminium alloys recommended for marine work; (2) British Standards and the available forms and sizes in which aluminium is supplied; (3) a note on the heat-treatment applied to appropriate materials in order to improve their strength and other properties. This bulletin is available to our readers on writing to Alar, Limited, at 33, Grosvenor Street, London, W.1.

Carron Mechanised Bath Foundry

*By Begbie McCall**

[SLIGHTLY ABRIDGED]

Towards the end of the second world war, it became apparent that, when foundries reverted to normal production, there would be a great shortage of skilled moulders. In anticipation of this, and in view of the post-war building programme, the Carron Company decided to install a mechanised bath foundry for the production of bath castings. This foundry came into operation in 1948, and consists of sand-conditioning and handling equipment; three Sandslinger moulding machine units; cupolas; Wheelabrator and dressing section.

THE ISOMETRIC VIEW of the plant recently installed by the Carron Company for the manufacture of bath castings (Fig. 1) shows the layout of the foundry, and the following is a brief description of the various operations. The central point of each moulding unit (a plan of which is shown in Fig. 2) is the Sandslinger, illustrated in Fig. 3, a machine with an arm rotating on a centre column. At the end of this arm is an impellor rotating at high speed. This impellor is fed with conditioned sand from an overhead belt-conveyor from the sand system and throws the sand at high velocity, simultaneously filling and ramming a moulding box. In each unit there are two cast-iron matched patterns, one to make the drag mould or inside impression of the bath, the other for the cope mould or outside impression. Fig. 8 shows the sequence of operations during ramming and preparation of a complete mould. The drag mould is rammed by the Sandslinger operator who guides his machine round the moulding box which is clamped on top of the pattern. Pattern and rammed moulding box are then lifted by an electric hoist, turned over, and conveyed by monorail to a slat conveyor where the pattern is drawn and returned to the moulding station, picking up an empty moulding box midway in readiness for the next mould to be rammed. While this transfer has been taking place, the cope mould has been rammed. This mould is lifted from the cope pattern, conveyed by monorail and lowered on to the drag (Fig. 4). On the way to the closing station, cores are inserted in the moulds to form feet, snugs, holes for the taps, *etc.* After closing, the cope and drag moulds are clamped together and the completed mould is moved forward on gravity rollers to the pouring station, where molten metal from the cupola is conveyed by monorail in a double-spouted ladle, each ladle containing sufficient metal to cast one bath (Fig. 5). Metal is fed to the mould by means of two downgates, one on either side of the bath. These downgates have runners which allow metal to enter into the mould along both edges of the casting.

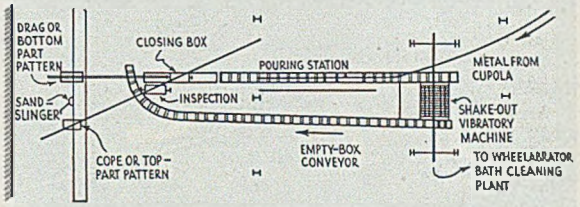


FIG. 2.—*Plan of One of the Three Moulding Units for Sandslinger Production of Bath Moulds.*

Shake-out and Sand Preparation

After pouring, the mould proceeds on a gravity conveyor to the shake-out, where cope and drag are separated and spent sand is shaken from the boxes and casting by means of a vibratory mechanism. Fig. 6 shows a

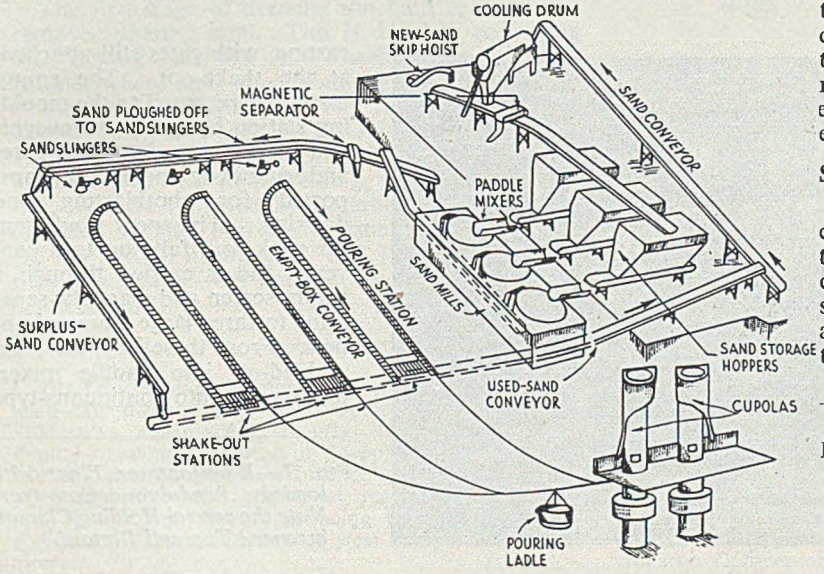


FIG. 1.—*Isometric View of the Mechanised Bath Plant at Carron Company showing Schematically the Various Items and the Mechanical Transport Facilities Connecting Them.*

* Reprinted from *Carron Cupola* by courtesy of the Carron Company, Falkirk. The Author is assistant bath-production manager; the diagrams are by Robert Duncan, chief engineer.

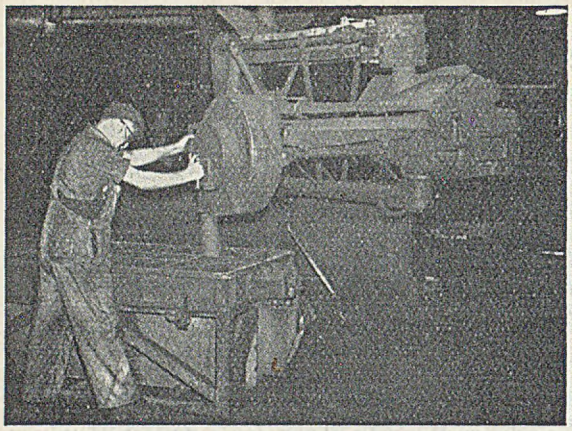


FIG. 3.—*Close-up of a Sandslinger in Operation for Ramming a Mould.*

FIG. 4.—*Finished Bath Mould-part (Cope) being withdrawn from a Pattern.*

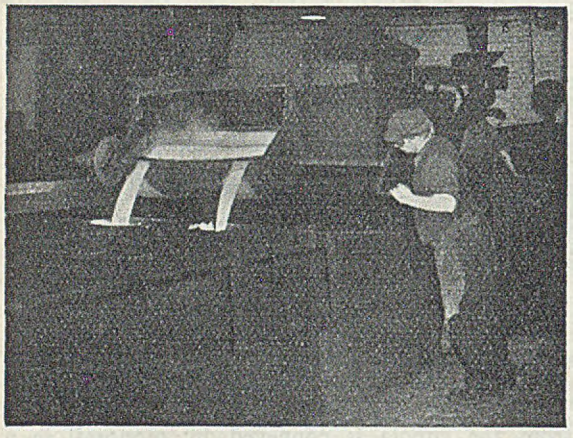


FIG. 5.—*Casting a Bath Mould from a Trough-type Ladle with a Double Spout.*

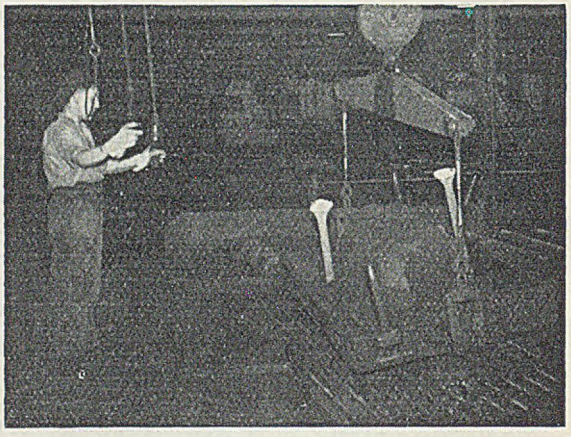
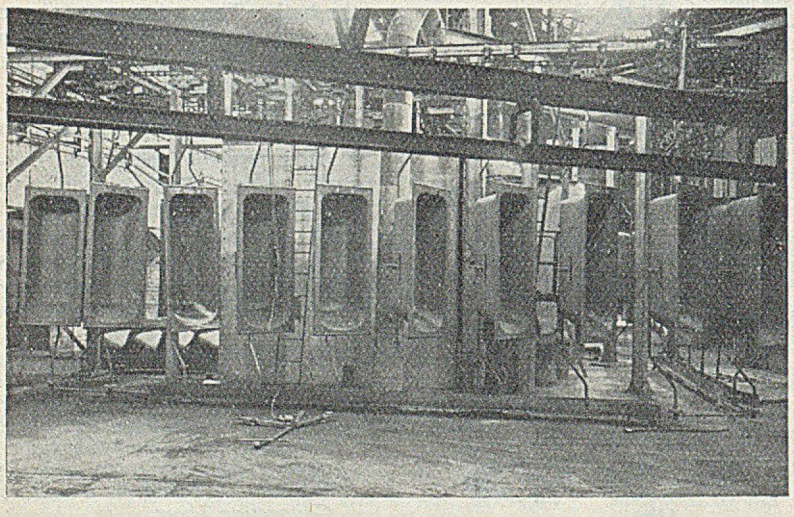


FIG. 6.—*Bath Casting, with Gates still attached, at the Vibratory Shake-out Station.*



casting, with gates still attached, at the shake-out. The empty boxes are returned to the moulding station by gravity conveyor, and the bath casting, with gates and runners removed, is transported for shotblasting and dressing. The spent sand from the shake-out falls on to a conveyor and is carried through a rotary screen and magnetic separator to three large storage hoppers. From these hoppers, sand is bled-off into paddle mixers discharging into continuous-type

FIG. 7.—*Wheelabrator Plant with loaded Pendulum Conveyor; Note the special Holding Clamps, arranged Top and Bottom.*

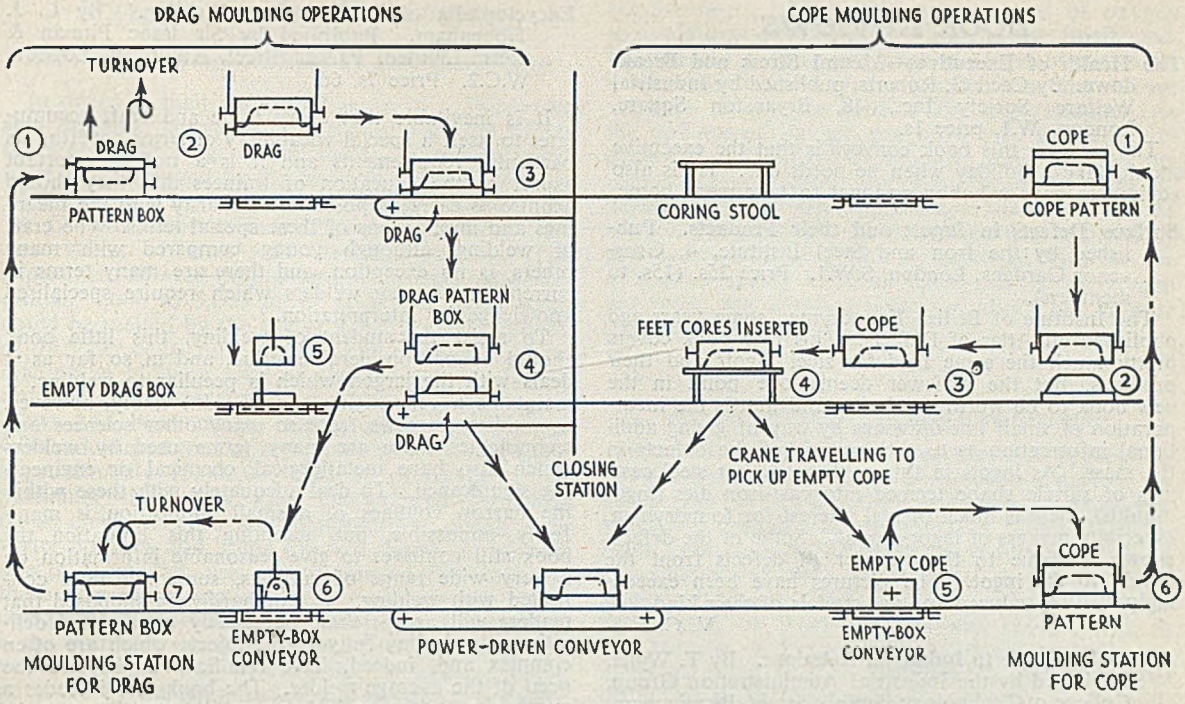


FIG. 8.—*Chart showing the Sequence of Operations and their Integration for producing Bath Moulds.*

roller mills. During the mixing and milling, water is added to bring the sand into a suitable condition for moulding. The conditioned sand is ploughed from the mills on to a belt conveyor, passed through an aerator and discharged on to another conveyor which conveys the sand over the Sandslingers. A plough, operated from the slinger head, feeds sand to the machine as required.

Dressing

The first stage of dressing the bath casting is to remove adhering sand. This is done by conveying the casting through a Wheelabrator—a large cabinet where steel shot from high-speed impellors is thrown at the casting from various angles, the casting being carried on a pendulum conveyor (see Fig. 9). The clean castings from the Wheelabrator are now ready for final dressing, where sharp edges, fins, *etc.*, are removed by portable grinders before despatch to the porcelain-enamelling department. All conveyors, lifting gear, and the like, are electrically operated and manual labour is reduced to a minimum.

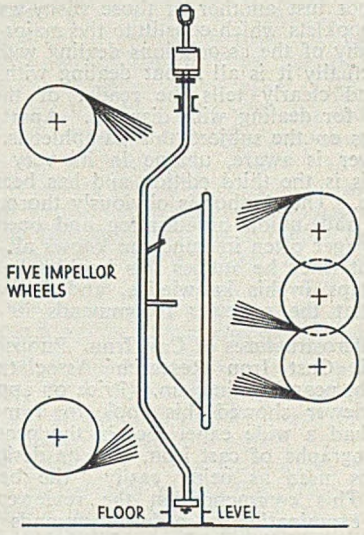


FIG. 9.—*Sketch of the Wheelabrator Shot-blast Plant for Cleaning Baths showing the Pendulum Suspension between Five Cleaning Impellor Wheels.*

THE GOVERNMENT proposes that summer time in 1952 shall extend from April 20 to October 26.

IT WAS ANNOUNCED recently by Mr. T. Brown, deputy managing director of Sheepbridge Engineering, Limited, that another new furnace is being constructed at Sheepbridge with additional research laboratories, and that a new factory is being built at Sutton-in-Ashfield for the production of steel components for jet aircraft.

SUBSTANTIAL ARRIVALS of foreign ore in the Tees during October increased the total imports into the port that month to 294,623 tons—17,000 tons more than in September and 37,000 tons more than in October, 1950. There was a decrease of 18,000 tons in the shipments of manufactured iron and steel in October, and clearances of coal declined by a similar amount. Total exports amounted to 103,154 tons, a decrease of 23,415 tons on October of last year.

Book Reviews

The Health of Executives—Mental Stress and Breakdown. By Cecil G. Roberts, published by Industrial Welfare Society Inc., 48, Bryanston Square, London, W.1, price 1s.

The message this book conveys is that the executive should take a holiday when he needs one. He is also advised to have a hobby and not to take work home.

Surface Defects in Ingots and their Products. Published by the Iron and Steel Institute, 4, Grosvenor Gardens, London, S.W.1. Price 25s. (15s. to members).

The Institute of British Foundrymen some years ago published an Atlas of Defects. This new book covers pretty much the same field for steel ingots and their products, but the reviewer deems one point in the new book to be worth emulation and that is the incorporation of small line-drawings by way of giving additional information as to the location of the defects in the mass. As ingots in this context are but steel castings of simple shape teemed into cast-iron dies (ingot moulds), there is much of real interest for foundrymen, especially makers of ingot moulds. Some of the defects shown are due to the transfer of defects from the mould to the ingot. The pictures have been exceedingly well reproduced and are models of their kind.

V. C. F.

A Concise Guide to Industrial Relations. By T. Wylie. Published by the Industrial Administration Group, College of Technology, Suffolk Street, Birmingham. Price 2s. 6d. post free.

The reviewer was just a little surprised to find that this was not just another of those wishy-washy platitudinous booklets which constitute the major output of all too many of the associations dealing with management. Actually it is all about dealing with the trade unions, and clearly tells the reader of the existing machinery for dealing with disputes. Apart from the legal tomes on the subject, this pamphlet is, so far as the reviewer is aware, unique in its very important field. This is the third edition and has been brought up to date. The Author is obviously thoroughly well versed in trade-union organisation and operation. A works manager often imagines he knows all about the subject, but when he studies this booklet he may well discover gaps in his knowledge, and it is on these grounds that the reviewer recommends its purchase.

Typical Microstructures of Cast Iron. Published by the British Cast Iron Research Association, Alvechurch, near Birmingham. (Price on application.)

The reviewer showed this book to a metallurgist, who has had a wide experience in the production of photomicrographs of cast iron, and he designated the illustrations used as being easily "the best in the world." This commendation the reviewer endorses from the examination of a few thousands that have passed through his hands. It should be realised that the book is "Typical Microstructures of Cast Iron" and not "Typical Microstructures of Iron Castings," as the two things are not exactly the same. In the latter, one would expect to see more emphasis on section thickness and, possibly, composite micrographs showing selected structures at 50, 200, and 1,000 diameters. The method of dealing with the subject has been, first, to illustrate the constituents of cast iron, then unalloyed cast irons, malleable cast irons and, finally, some typical defects. Altogether there are 38 pictures, and for the beauty of their reproduction both the block maker and printer must be given high praise for the work they have done.

V. C. F.

Encyclopædia of Oxy-acetylene Welding. By L. J. Tibbenham. Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 7s. 6d.

It is inevitable that every trade and craft accumulates to itself a special vocabulary of terms covering its particular requirements and it is a not unimportant aspect of the education of trainees that they should acquire as early as possible familiarity with the meanings and implications of these special terms. The craft of welding, although young compared with many others, is no exception, and there are many terms in current use among welders which require specialised knowledge for interpretation.

To assist the student of welding, this little book should be of considerable value, and in so far as it deals with the jargon which is peculiar to welding, it maintains a very high standard. Inevitably, however, as welding borrows from so many other sciences and technologies there are many terms used by welders which also have metallurgical, chemical or engineering significance. To deal adequately with these within the narrow confines of a small publication is manifestly impossible, but accepting this limitation the book still contrives to give reasonable information on a very wide range of subjects, some but little connected with welding. It can hardly be supposed that readers will accept these necessarily abbreviated definitions as dealing fully with subjects which are often complex and, indeed, have ramifications beyond the need of the average welder. The book also includes a number of tables and charts which contribute to its value.

Workshop Books: Handmoulding. Selected examples of modern practice for practical men. Second edition by Fr. Naumann, published by Springer-Verlag, 20, Reichpietschufer, West Berlin, W.35. Price 3.60 D.M.

It is assumed that the reader is already familiar with the general practice of pattern moulding and foundry work; any omissions from the text will not trouble those who are acquainted with the best modern practice.

In the chapter headed "Pattern Moulding" are described: Moulding of a drilling machine; the production of a hard-to-mould motor housing; moulding of a machine base and an oil-pump housing; the practical moulding of cored castings; moulding of sheaves and like items of greater breadth than the available pattern; moulding of cog-wheels. In the chapter headed "Loam Moulding" there are descriptions of the strickle board, moulding a sheave by strickling; moulding a triple-grooved sheave, loam moulding cog-wheels, etc.; production of a dish with supports by loam moulding; multi-spindle strickling; segmental housings. Under the heading "Use of Auxiliary Plaster Patterns" are described: application of plaster patterns to the production of a drilling apparatus; plaster patterns for a ventilator support; use of plaster for the re-shaping of patterns. In the chapter "Moulding from Drawings without a Pattern" the Author deals with the production of a simple pulley, moulding of a levelling plate and an unusual type of flanged tube.

The book contains further important data in the form of footnotes regarding moulding sand, calculation of stresses, and suitable pattern plasters. 217 line drawings are included. Although the book contains very little that is not already known in foundries, it is to be recommended to practical foundrymen, since each chapter contains in concentrated form a great deal of information and "know-how" for daily application.

Oxygen in the Converter

Hot-metal Shortage Bridged by Increased Scrap

In order to melt additional scrap in a 28-net-ton acid-Bessemer converter over a period during which there was a shortage of hot metal, oxygen-enriched blast was employed by the National Tube Company, McKeesport, Pa., the results being reported by W. G. McDonough in a Paper presented to the Association of Iron and Steel Engineering. The experiment showed that under normal operating conditions, 4,000 to 5,000 lb. of additional steel scrap could be melted by the use of 4,000 to 6,000 cub. ft. of 99.5 per cent. pure oxygen per blow, with a reduction in blowing time of about 1 min. To the time the Paper was written, more than 2,900 oxygen blows had been made, during which time about 6,000 additional tons of scrap had been melted, using approximately 15,000,000 cub. ft. of oxygen. No particular difficulties were encountered regarding flame characteristics and temperatures, while converter bottoms and lining life had shown no adverse effects from the use of oxygen; on the contrary, there was indication of some improvement. The conclusion was reached that about 26 per cent. scrap is the optimum that can be used in a Bessemer converter charge, the percentage, of course, being governed by the composition and temperature of the iron, and other operating factors. As the scrap charge is increased, the hot-metal charge must be decreased to maintain normal heat weight, thus reducing the proportion of charge elements which produce heat. This reduced amount of hot metal to be blown also reduced the blowing time, limiting the period in which oxygen could be introduced and efficiently used without leaving an excessively oxidised condition in the bath.

A graph shows that after a definite method for using oxygen had finally been established, the oxygen per blow fell from 15,000 cub. ft. to 4,500 cub. ft., the additional pounds of scrap melted per thousand cubic feet of oxygen being increased from about 400 up to nearly 1,000. Present practice indicates that within certain limits almost 1,000 lb. of additional scrap can be melted per 1,000 cub. ft. oxygen, with the upper limit at 5,000 lb. of additional scrap per blow. The experience also indicates that any use of oxygen above 4,000 to 6,000 cub. ft. per blow led to its inefficient use, and possible over-oxidation, adversely affecting quality, yields, and costs.

Increased Iron in Slag

Indications were that the introduction of oxygen during the blow was producing a slag higher in iron-oxide content, and more fluid than before, this being especially true when the oxygen was used in larger volumes and left on until near the end of the blow. These facts indicate a slightly higher loss of metal to the slag, which is partially counteracted by a lesser volume of slag through a reduction in the hot metal used. Due to the higher FeO content of the finished metal and slag, manganese efficiency was slightly lower on oxygen-blown Bessemer heats than on regular heats, while, with close control of oxygen to avoid over-oxidation, steel quality was unaffected. Neither did the nitrogen content of the blown metal or finished product give evidence from the various volumes of oxygen used in the experiments. As the volume of oxygen per blow was gradually reduced, the reduction in blowing time through the use of oxygen became less pronounced. In early experiments using from 9,000 to 12,000 cub. ft. of oxygen per blow, the blowing time was reduced by two to three minutes. Later, however, with the use of approximately 4,000 to 4,500 cub. ft. of oxygen per blow, the blowing time was about one minute less than normal.

Accident-prevention Conference

Interesting facts concerning accident prevention in industry emerged at the conference organised by the Royal Society for the Prevention of Accidents which was held in Glasgow recently. About 700 delegates from industry throughout Scotland attended the conference, which was designed to make Scottish workers more safety-conscious. The conference threw light on local methods and results, and, as has become customary in the course of such discussions, drew fruitful comparisons with standards obtaining in the United States. Mr. G. P. Barnett, H.M. Chief Inspector of Factories, said that each year in industry in England, Scotland, and Wales, approximately 200,000 accidents occurred which involved more than three days' absence from work; 772 accidents proved fatal in 1949. Scotland's share of this total was disproportionately high, running at 24,000 accidents annually with 111 fatalities in 1949, and was attributed to the preponderance of heavy industry in Scotland. There was a general rise in the number of accidents due to machinery, Mr. Barnett continued, owing to increased mechanisation. The responsibility for carrying out safety regulations and inculcating a safety-conscious spirit fell on the supervisory grades in industry, and much could be accomplished by maintaining a high standard of housekeeping within the individual factory.

On the comparative merits of British and American practice, speakers generally agreed that, though standards of safeguarding machinery and plants were higher here, American workers were as a rule more safety-conscious. The enthusiasm for safety at all levels in industry across the Atlantic had yet to be achieved here, observed Mr. D. H. Brown, director of production at the Edinburgh factory of the North British Rubber Company, Limited. One Glasgow works manager doubted whether the powers vested in the factory inspectorate of the Ministry of Labour and National Insurance were adequate, and called for the law to deal more severely with offenders against safety regulations.

Tributes were paid to Sir Robert Hyde, who founded the Industrial Welfare Society 33 years ago, at the society's annual meeting in London on December 5, when it was announced that he would retire from the staff at the end of this year.

Renewing the Dollar Drive

Greatly Strengthened Dollar Exports Council Formed

Many prominent British industrialists with wide experience of the North American markets have joined the new and greatly strengthened Dollar Exports Council, the formation of which was announced on December 12, which is to renew the dollar export drive. The new body has been formed by industry and is sponsored by the national industrial, commercial, and financial organisations. It has the full support of the Government, with which it has been agreed that high officials of the Treasury, the Board of Trade, and the Ministry of Supply will hold themselves in readiness to join in the discussions of the council in all matters where Government policy is involved.

To ensure co-ordination of policy and effort on both sides of the Atlantic, leading businessmen in Canada and the United States have been appointed as overseas members of the council. For the direction of the day-to-day work in this country, a new executive committee has been formed, and immediate steps are being taken to appoint a whole-time chief executive.

When the former Dollar Exports Board was wound up last June, it was succeeded by the Dollar Exports Advisory Council, which had advisory powers only. Since then, the worsening of the dollar situation has made it imperative that an organisation of much wider scope should be established, which could go out to industry and take positive steps to assist and encourage individual firms and industries in their dollar sales problems.

Many Problems to Overcome

Announcing the formation of the new council, Sir Archibald Forbes, president of the Federation of British Industries, acting for Sir William Rootes, the chairman of the Dollar Exports Council who is at present in the United States, said that the new organisation was being set up under the energetic leadership of Sir William Rootes to ensure that industry would have all possible help in overcoming the many difficult problems of exporting to the North American and other dollar markets.

"We realise that in present conditions the difficulties are very great and that in some trades the immediate problem is to maintain the existing volume of sales rather than to increase it," he continued. "We hope that firms already exporting to these markets will come and discuss their problems with us and we also want to give every practical encouragement to the large number of firms who have not yet entered the markets. We are confident that, with the continued efforts of industry and the help that the new Dollar Exports Council will be able to give them, further increases in dollar sales can be obtained."

Sir Archibald also announced that the council had received the following message from Mr. Peter Thorneycroft, President of the Board of Trade:—

"I am extremely glad to hear of the steps which the Dollar Exports Council is taking to reinforce its activities. The economic circumstances of today make exports more important than ever. And among exports, those to the dollar markets continue to rank first. I am sure the steps which you are taking will prove a valuable contribution towards meeting a national need and I would like to assure you of the Government's support and warm appreciation of your action."

The council's chairman, SIR WILLIAM ROOTES, is chairman of the Rootes group of companies, the members in the United Kingdom being LORD BILSLAND, chairman of the Scottish Council (Development and Industry), SIR ERIC CARPENTER, chairman of Greg Bros. & Company, Limited, SIR CHARLES COLSTON, chairman of Hoover, Limited, SIR ARCHIBALD FORBES, SIR PATRICK HANNON, president of the National Union of Manufacturers, SIR CHARLES HAMBRO, chairman of the Financial Advisory Panel, MR. J. L. HEYWORTH, a director of Lever Bros. & Unilever, Limited, MR. A. H. S. HINCHLIFFE, president of the Association of British Chambers of Commerce, SIR NORMAN KIPPING, director-general of the Federation of Briitsh Industries, SIR PERCY LISTER, chairman of R. A. Lister & Company, Limited, SIR LEONARD PATON, a director of Harrisons & Crosfield, Limited, SIR ROBERT SINCLAIR, chairman of the Imperial Tobacco Company, Limited, SIR VINCENT TEWSON, general secretary of the Trades Union Congress, SIR JAMES TURNER, president of the National Farmers' Union, SIR CECIL WEIR, chairman of the British Tabulating Machine Company, Limited, and SIR JOHN H. WOODS, a director of the English Electric Company, Limited.

Mr. Laurence Heyworth has undertaken to serve for one year as chairman of the new executive committee. Sir Charles Hambro and Sir Leonard Paton will serve as members of the committee together with MR. W. P. N. EDWARDS, deputy overseas director of the F.B.I., SIR LEONARD BROWETT, director of the National Union of Manufacturers, MR. ARTHUR KNOWLES, secretary-general of the Association of British Chambers of Commerce, and DR. C. MACRAE, secretary of the Scottish Council (Development and Industry).

A whole time chief executive will be appointed to take charge of the day-to-day work of the council. He will be assisted by MR. R. HUNT-TAYLOR, MR. D. WIDDOWSON, and MR. F. DAVIES. Mr. Widdowson has been appointed secretary to the council and the executive committee, which has offices at 41, Buckingham Palace Road, London, S.W.1 (Telephone Whitehall 6711).

North American Organisation

The council, through its overseas members, will continue to maintain the closest contact with its corresponding organisations and executive agencies in Canada and the United States. In Canada these are the Canadian Dollar-Sterling Trade Advisory Council, and its executive body the British Trade Centre, Toronto, operated by the Canadian Association of British Manufacturers and Agencies, the general manager of which is MR. JOHN L. BONUS. In the United States the corresponding organisation is the British Trade Promotion Centre, New York, operated by the British Commonwealth Chamber of Commerce in the U.S.A., whose chief executive is MR. DUNCAN M. S. MOWAT. In the United Kingdom the council will also maintain contact as required with the Canadian and American Chambers of Commerce in Great Britain.

MR. JAMES S. DUNCAN, president of the Dollar-Sterling Trade Advisory Council, has agreed to act as chairman of the Canadian group, the other members being MR. LEWIS J. B. FORBES, president of the Canadian Association of British Manufacturers and Agencies, and MR. H. R. MACMILLAN, president of the H.R. MacMillan Export Company, Limited.

The chairman of the United States group is SIR WILLIAM WISEMAN. SIR ROBERT APPLEBY, president of Robert Appleby & Company, Inc., MR. A. W. BEAMAND, president of the British Commonwealth Chamber of Commerce, Inc., and MR. A. BRACKENRIDGE, president of Morton Sundour, Inc., complete the membership of the U.S. group.

Casting Phosphor-bronze Rings on Cast-iron Wheels*

Introduction

Bimetallic assemblies often permit of economy in the use of large quantities of copper alloys, and in certain cases combine the wear-resisting properties of bronze with the mechanical properties of steel. The adherence of bronze to cast iron is particularly difficult to achieve. It is presumed in what follows, that a tangent screw wheel is to be made.

Preparation of the Iron Casting

It is always desirable to provide a mechanical anchorage to ensure the solidity of the bronze/cast-iron assembly. Perfect cleaning of the casting is essential so as to free it from the smallest cavities, and the re-entrant angles from all non-metallic impurities. All mechanical devices such as blasting and scratch brushing may be used. Then degreasing is carried out by the use of a 5 per cent. (by weight) solution of trisodium phosphate. The casting is well rinsed whilst using a scratch brush, after which it is carefully dried. Pickling is carried out with a warm solution (about 50 deg. C.) of 50 gm. per litre sulphuric acid. A further process is to prepare the surface for zinc-ing using a solution of zinc chloride of the following composition:—

Ammonium chloride	75 to 80 gm.
Zinc chloride	75 to 80 gm.
Water	1 litre.

The casting is dried by heating to avoid projection of metal during the later zinc-ing. After the pickling, which has for its object the production of a clean and "tinnable" surface, it is necessary to have an intermediate zone between the bronze and the cast iron is either copper- or zinc-faced.

If zinc-ing be chosen, this can be carried out by immersion for 6 to 10 min. in a zinc bath held at about 500 to 600 deg. C. long enough to ensure an equalisation of temperature throughout the casting. The percentage composition of the bath is as follows:—Copper, 1.5; lead, 1 to 2; tin, 1 to 2; iron, 1; and zinc, the remainder per cent.

The surfaces which are not required to be zinced, are covered with a coating of magnesia and silicate of soda, or "Meudon" white. As soon as the wheels are removed from the zinc bath, it is good practice to powder them with salammoniac. By so doing, the entrainment and adherence of dirt on the dies is avoided. The steps taken in the shop should be such that after this treatment the wheels should be placed in the dies and cast as quickly as possible. The layer of zinc should attain temperatures up to 450 deg. C. under optimum conditions. It is useless to attempt casting if the zinced wheel has cooled below 150 deg. C.

Lay-out for Casting

The method utilising a ring runner in association with pencil gates has been previously described.† This method can be used with advantage, for it allows an equal supply of liquid metal to be run throughout the section. In the case of a ring 8 mm. thickness as cast, having an inside diameter of about 300 mm. (1 ft.) the parallel section of the ring has a surface of the order of 5,000 sq. mm. Feeding is done by means of pencil gates, assuring a feeding ratio of about 4 to 6 per cent., that is to say, by 4 to 6 holes of 50 sq. mm. section (8 mm. diameter).

The cast iron is in itself a powerful chill. Nevertheless, it is necessary to set in the top side an allowance of the order of about 10 per cent. of the height of the ring. Casting should be carried out immediately, the dried mould being placed as vertically as possible, so that the walls may not be scored by the metallic streams. The feeding section of the runner ring is about 10 per cent. greater than the sum of the whole of the sections of the pencil gates, to ensure that the gates are always full. It is essential to synchronise the operations of moulding, closing, and casting, so as to ensure that neither the melting, nor the cast-iron wheel after preparation, nor the mould after closing, suffer from delays.

Preparation of the Bronze

High-grade metals should be used, for example a phosphor bronze, or an 88/12 bronze conforming strictly to the specification such as No. C321 issued by the (French) *Ministère de la Marine*. The metal is cast without superheating, after refining and a careful deoxidation, so as to obtain a homogeneous structure of fine grain. A metal showing a heterogeneous structure will not have the elongation necessary to take care of the strains set up by the freezing. In any case, it is essential to allow no aluminium, silicon, or iron to be present. After casting and stripping, it is as well to submit the components to a homogenisation re-heating treatment to remove stresses. This can be carried out at a fairly low temperature, of the order of 300 deg. C. for about 5 hrs., this period being governed by the weight and shape of the component.

Inspection

In addition to the usual tests, the following can be usefully carried out. The unmachined wheel is plunged into an oil bath and allowed to soak for some time; then it is placed flat on a steel sheet heated to 100 deg. C. This removes the surface oil, but if the oil has entered between the iron/bronze joint, it shows up along the line of the joint as large brown spots.

* Translated from *Fonderie*.

† Running Iron Castings: Use of Pencil Gates in a Ring Runner by P. Rigaut. FOUNDRY TRADE JOURNAL, September 24, 1950, pages 283 and 284.

Lining a Rough Pattern

Following a culinary precept, one of our readers overcame a stripping difficulty when using a rusty bush casting, provided as pattern, by lining it both internally and externally with thin cardboard. Two holes were drilled and tapped in the top of the bush pattern for the insertion of lifting screws and no difficulty was experienced in withdrawing the pattern from the mould.

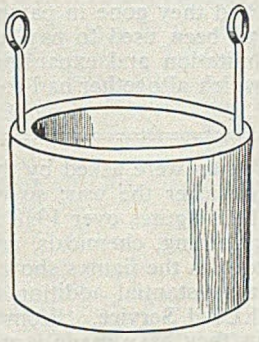


FIG. 1.—*Bush Pattern prepared by inserting Lifting Screws and Lined with Cardboard to give Easy Stripping.*

Need for Good Profits

At the annual general meeting of Tube Investments, Limited, the chairman, Mr. Ivan A. R. Stedeford, was able to report "another year of records on all fronts—in production, sales, exports, productivity, and profits." Trading profits totalled £7,776,773, compared with the previous year's record of £6,282,651 — an increase of nearly £1,500,000. "If after taxation and depreciation the company is allowed to keep only £290,000 of the increase in profits, this should not deprive us of a certain sense of achievement," he said. Mr. Stedeford emphasised that had there been adequate supplies of raw materials, the results would have been better still, for in few instances were the factories able to work to full capacity. Nevertheless, the volume of T.I. output and direct export sales were, respectively, 50 per cent. and 100 per cent. greater than they were four years ago—"a gratifying increase in so short a period in what are perhaps two of the country's most vital needs at the present time."

Mr. Stedeford said that that those results were possible should give the country confidence in facing the present international situation. Certainly she was much better placed industrially today than she was in 1939. But the fact that industrial profits generally should go up at a time when the cost of living was rising seemed to have created a feeling in some quarters that one section of the community had been benefiting unduly in times of difficulty at the expense of the other. There would always be the few who, in times of stringency, endeavoured to gain unfair advantages for themselves, but generally the idea was false; indeed, it could be mischievous, for without a clearer understanding generally of the nature of profits and what was done with them, it tended to cleave our national unity.

The purpose of an industrial company was to produce more and better goods at relatively lower prices; to strive to provide a good and secure living for its employees; and to provide a safe investment with a reasonable return for those who found the money for the enterprise. That good profits should arise in fulfilling these aims should not cause concern or suspicion. What was done with them was the real question. T.I.'s profits had not been obtained by high prices, nor had they gone in paying higher dividends. They had been used to pay for post-war schemes of rehabilitation and expansion, both at home and abroad, which altogether had cost so far over £17,000,000.

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the miscellaneous class. Women were asked by the Government to stay at work after the war; so we find a big increase in the 1948 figures over 1938 in some occupations, *e.g.*, engineering, chemicals, and vehicles. In clothing and textiles the figures show a drop, partly made up by a substantial addition to those in the non-industrial Civil Service. Women still earn less than men, but they have made larger gains, their average hourly earnings having increased by 134 per cent. in 10 years, as against an increase of 99 per cent. for men.

Fuel Resources

Foundrymen who have been disturbed by the vision of a world depleted of its fuel resources may find comfort in the assurances of Mr. C. T. Brunner, made during the course of the Henry Spurrier Memorial Lecture before the Institute of Transport in London recently, that both coal and oil would in time be outmoded, probably before there was any question of the exhaustion of reserves. Instead, man would find means of harnessing the tides, utilising the energy of the sun, and applying nuclear fission to power-station processes and other operations. The speaker, who is a director and general manager of Shell-Mex & B.P., Limited, said that in the meantime the reluctance of modern labour to enter the mines, and the natural limitations on the production of hydro-electric energy, inclined the world to look to the oil industry for any expansion of its supply of power. Over the last 12 years the proportion of the world's power provided by oil had increased from 26 per cent. to 36 per cent. Significantly, three years ago, in the United States oil had already outstripped coal in its contribution to the generation of power, Mr. Brunner observed.

If Britain had lost her ascendancy in the international coal trade, this had been offset, he continued, by the impressive development of her stake in oil. Between them, the British and British-Dutch companies accounted for over 40 per cent. of the oil going into world markets last year. British firms manufactured oil-industry equipment to the value of £70,000,000 last year, of which £50,000,000 worth was exported.

Population and Age Trends

In the last two years the Employment and Training Act has come into full operation; in most areas the local education authorities have submitted schemes; elsewhere the duty is undertaken by the Ministry of Labour. Nearly all the new entrants into National Insurance are given individual advice, especially those under 16. The number of students in "further education establishments" has been rising steadily, being two and a half times as many as before the war. An inquiry made in 1950 showed 39 per cent. of boys entering industry through apprenticeship, but only 6 per cent. of girls; building gives the highest percentage for boys, and textiles for girls.

Until recently the population of Great Britain was growing, with a corresponding addition to the working force. In the future the figures may be different; men in the highest age group—44 to 64—may keep up, but below 44 the number will fall; in the case of women of working age, the numbers are expected to fall for all age groups.

A table showing the proportions of boys and girls entering industry before and after the last war suggests that more boys are entering the manufacturing and building trades and fewer choose the distributive trades; fewer girls are found in manufacturing and in the distributive trades, but far more go into

(*Concluded at the foot of col.* 1)

Corrosion of Buried Metals

There is still a lack of fundamental knowledge in the phenomenon of corrosion, particularly that of buried metals. A symposium, sponsored by the Iron and Steel Institute, B.I.S.R.A. and the Corrosion Group of the Society of Chemical Industry, was held last week in London, when some recent results of research on corrosion of buried metals were discussed.

Little organised research on the corrosion of buried ferrous metals was conducted in Great Britain before 1940, but investigations, some of a long-term nature, have been started and developed since by a number of different research groups. Increasing interest has been shown in the use of special inhibitors to reduce losses by corrosion, and also in the application of cathode protection in an attempt to reduce in future the expense involved in replacing corroded buried pipe-lines. A symposium on the corrosion of buried metals, in which many aspects of this phenomenon were discussed, was organised by the Iron and Steel Institute, B.I.S.R.A. and the Corrosion Group of the Society of Chemical Industry and held at the offices of the Institution of Electrical Engineers in London on Wednesday, December 12, SIR CHARLES GOODEVE presiding. There were six Papers including " Tests on the Corrosion of Buried Iron and Steel Pipes " by J. C. HUDSON and G. P. ACOCK; " Investigation of Underground Corrosion " by K. R. BUTLIN, W. H. J. VERNON, and L. C. WHISKIN; " Cathodic Protection " by K. A. SPENCER; " Cathodic Protection of Buried Metal Structures " by M. R. DE BROUWER; " Corrosion of Buried Copper and Ferrous Strip in Natural Salted Soils " by G. MOLE; " Tests on the Corrosion of Buried Aluminium, Copper and Lead " by P. T. GILBERT and F. C. PORTER. Points of interest to foundrymen from the technical sessions are appended below.

TESTS ON THE CORROSION OF BURIED IRON AND STEEL PIPES

By J. C. Hudson, D.Sc., and G. P. Acock, B.Sc.

This Report concerns the corrosion of cast-iron pipes and steel tubes buried in five representative soils in Great Britain for five years. The results relate to specimens tested both bare and with various protective coatings.

Cast-iron Specimens

Three types of cast iron, vertically cast, metal-spun, and sand-spun, were tested, specimens being cut from 4-in. internal diameter class B pipes taken from current production. Analyses of the irons are given in Table I. The pipes were made by the normal processes and the following is a summary of the essential features of the observations made at the time.

Vertically Cast.—The pipes were cast vertically in red-sand moulds with cores struck on perforated cast-iron bars, and were blacked with a wash of fine coke, water, and clay. The casting temperature was between 1,250 and 1,300 deg. C. Fourteen 9-ft. pipes were used for the production of the specimens.

Metal Spun.—The metal mould used to produce the metal-spun pipes was fluxed with ferro-silicon powder. Eight 18-ft. pipes were cast for the tests, each being spun for 20 sec. The casting temperature was between 1,130 and 1,150 deg. C. Immediately after casting, the hot pipes were placed for 30 min. in an automatic annealing furnace maintained at 850 deg. C.

Sand Spun.—The moulds used for the sand-spun process were lined with a synthetic moulding sand consisting of Leighton-Buzzard sand and sand-wash bonded with clay-wash. The moulds were blacked and skin-dried before use. Twenty-seven 16-ft. pipes were cast for the production of specimens; the casting time was 3½ min. and the speed of the mould 1,100 r.p.m. The casting temperature was between 1,275 and 1,310 deg. C.

Steel Specimens

Three types of steel tube were selected to represent current tube production, namely lap-welded tube (4¾ in.) of open-hearth rimming steel, seamless tube (4¾ in.) of open-hearth killed steel, and galvanised butt-welded tube (1$\frac{1}{16}$ in.) of basic Bessemer rimming steel. Analyses of the steels are given in Table I.

Conditions of Exposure

Particulars of the five exposure sites chosen for the tests are as follow:—

Benfleet.—The site is at a sewage pumping station of the Benfleet Urban District Council on Benfleet Marsh. This is a flat alluvial tract

TABLE I.—*Percentage Analysis and Tensile Strength of the Cast Irons and Steels.*

Material	C		Mn	Si	P	S	Cr	Cu	Mo	Ni	Ti	V	Tensile strength, tons/sq. in.
	Total.	Graphitic.											
Cast iron—													
Vertically cast	3.35	2.69	0.62	2.13	1.44	0.070	0.16	0.04	0.04	0.14	0.14	0.10	12.1
Metal-spun	3.34	3.29	0.36	2.26	1.34	0.073	0.12	0.09	0.04	0.12	0.18	0.10	19.5
Sand-spun	3.23	2.60	0.61	1.92	1.05	0.076	0.14	0.09	0.04	0.12	0.11	0.10	11.6
Steel—													
O.H. rimming	0.088	—	0.38	0.001	0.030	0.022	—	0.035	—	0.10	—	—	23.78
O.H. killed	0.120	—	0.46	0.061	0.025	0.030	—	0.060	—	0.10	—	—	24.38
Basic-Bessemer rimming ..	0.048	—	0.31	0.001	0.029	0.030	—	0.010	—	0.03	—	—	23.61

surrounded on the west, north, and east by gently rising hills of London clay, and on the south by the creek that separates Canvey Island from the mainland. The site is on the landward side of the sea wall and drained by dykes. The deposit is alluvium or reclaimed salt marsh.

Pitsea.—The site is at the Pitsea pumping station of the Southend Waterworks Company. The deposit is London clay, the surface sloping gently southward to the Thames alluvium, the margin of which is 170 yd. from the site.

Rothamsted.—The specimens are buried inside the rain-gauge enclosure of the Rothamsted Experimental Station. The deposit is clay with flints of glacial origin, consisting of a heterogeneous mixture of Tertiary and Cretaceous material.

Gotham.—The site is at a sewage works of the Basford (Notts.) Rural District Council, and lies on Gotham Moor, an extensive flat alluvial tract fringed to west and south by rising ground occupied by Keuper Marls, in which gypsum is abundant.

Corby.—A trench was dug between two tracks of the goods sidings, south of Corby and Weldon Station of the London Midland Region (formerly L.M.S.R.), British Railways, on a made-up embankment, laid down in 1937.

Records of the soil profile in the exposure trenches were made at each site, except Corby. There would have been no point in taking a soil profile at Corby, where the " soil " consisted entirely of ashes. An analysis of a sample of ashes from Corby showed: Loss on ignition, 19.9 per cent.; sulphate, 27 p.p.m.; chloride, 10 p.p.m.; *p*H of water extract, 7.14.

Comparison of the Bare Ferrous Metals

To facilitate a comparison of the relative corrosion resistance of the various irons and steels tested when buried in the soil, the results given in Table II, in conjunction with depth of pitting, have been used to compile orders of merit on the different materials for each of the four main sites based on pitting and on loss in weight. These orders are shown in Table III. In several cases, two or more materials have been given equal rankings in the order of merit based on pitting because of difficulty in distinguishing between the seriousness of isolated deep pits or a larger number of slightly shallower pits. The smallest weight loss and least pitting have, in each case, been taken as first in the order of merit. It is clear from this analysis that the seamless steel pipes suffered least pitting at all the sites and that at most of them the vertically-cast cast-iron pipes were the worst in this respect. The individual orders of merit of the materials based on loss in weight are less consistent, but if both orders of merit, *i.e.*, that based on pitting and that based on loss in weight, are treated as equally significant, the overall result places the seamless steel as the best of the five materials and the vertically-cast cast iron as the worst.

The agreement between the position of each material in the two orders of merit for each site is consistently better for the cast-iron pipes than for steel. The results as a whole suggest that the seamless steel is characterised by relatively high resistance to pitting but that its resistance to general corrosion, as revealed by loss in weight, is of the same order as that of the cast irons. However, good resistance to pitting must be considered the more important factor, since the average loss in thicknesses calculated from weight loss must be smaller than the depths of the pits.

Important Evidence

The evidence presented, state the Authors, shows that there is little to choose between the whole range of ferrous materials tested so far as resistance to corrosion by soil is concerned. In particular, the

TABLE II.—*Weight Losses* and Calculated Penetrations for Ferrous Specimens.*

Material.	Benfleet.		Gotham.		Pitsea.		Rothamsted.		Corby.	
	Wt. loss, oz./sq. ft.	Equivalent uniform penetration, mils.	Wt. loss, oz./sq. ft.	Equivalent uniform penetration, mils.	Wt. loss, oz./sq. ft.	Equivalent uniform penetration, mils.	Wt. loss oz./sq. ft.	Equivalent uniform penetration, mils.	Wt. loss oz./sq. ft.	Equivalent uniform penetration, mils.
Vertically-cast pipes ..	2.1	3.3	2.2	3.5	5.7	8.8	2.5	5.1	—	—
Metal-spun pipes ..	2.2	3.4	1.6	2.4	3.8	5.9	1.5	2.3	5.4	8.4
Sand-spun pipes ..	1.7	2.6	1.2	1.9	5.8	9.0	2.3	3.5	—	—
Seamless steel pipes ..	2.3	3.6	1.8	2.8	4.0	6.2	1.9	3.0	—	—
Welded-steel pipes (as-rolled)	2.4	3.8	1.7	2.7	3.6	5.5	1.4	2.2	5.5	8.6
Welded-steel pipes (pickled)	—	—	1.3	2.0	—	—	—	—	—	—
Steel flats	2.4	3.8	1.6	2.5	4.6	7.3	2.6	4.0	6.9	11.0

* The weight losses are averages for triplicate specimens

TABLE III.—*Orders of Merit of Bare Pipes Based on Pitting and Weight Loss.*

Material.	Benfleet.		Gotham.		Pitsea.		Rothamsted.		Aggregate.		Overall order of merit.
	Pitting.	Weight loss.	Pitting.	Weight loss.	Pitting.	Weight loss.	Pitting.	Weight loss.	Pitting.	Weight loss.	
Cast Iron—											
Vertically cast ..	4	2	5	5	4	4	4½	5	17½	16	5
Metal-spun	5	3	4	2	2	2	3	2	14	9	3
Sand-spun	3	1	2	1	4	5	2	4	11	11	2
Steel—											
Seamless	1	4	1	4	1	3	1	3	4	14	1
Welded (as-rolled) ..	2	5	3	3	4	1	4½	1	13½	10	4

data refute the view frequently expressed that centrifugally-cast cast iron is intrinsically more liable to corrosion than vertically-cast cast iron. In fact, considered broadly, the results support the view that differences in wall thickness reflecting the different mechanical properties of the iron or steel are the primary cause of many of the differences that have been reported in their resistance to soil corrosion. Different irons and steels can be adequately compared only when the comparison relates to pipes of equal wall thickness.

INVESTIGATIONS ON UNDERGROUND CORROSION

By K. R. Butlin, W. H. J. Vernon and L. C. Whiskin

A Paper contributed by K. R. Butlin, W. H. J. Vernon, and L. C. Whiskin deals with investigations on underground corrosion. Part I describes investigations carried out at the Chemical Research Laboratory, Teddington, since 1934. Laboratory work includes fundamental studies on sulphate-reducing bacteria—their morphology, culture, and inhibition, and their effect on iron in anærobic neutral conditions. Field investigations, mainly in collaboration with water and gas engineers, include direct observation of freshly-exposed corroded pipes and the correlation of the presence of sulphate reducers with corrosion; tours of inspection of pipelines exposed at selected points; and (in collaboration with the Institution of Water Engineers) the collection of evidence from corrosion failures experienced by large water undertakings. It is concluded that the most widespread and dangerous form of underground corrosion takes place in neutral waterlogged soils and is associated with sulphate-reducing bacteria. Part II describes experiments on the protection of ferrous pipes carried out by the Laboratory in collaboration with the Metropolitan Water Board. Tests with conventional protective materials (applied to an actual water system) suggest that adequate bitumen sheaths, concrete coverings, and gravel surrounds provide good protection. Other tests on unconventional protective materials (applied to buried test specimens) are in progress.

CATHODIC PROTECTION

By K. A. Spencer, B.Sc.Tech.

Cathodic protection is principally applied to buried or submerged ferrous metal structures, so that in this Paper attention is confined to such items as pipelines, tank bottoms, and jetty piling, etc.

Causes of Corrosion

Discussing the causes of corrosion, the Author states that any buried or submerged structure may be regarded as coming in contact with an electrolyte, and under these conditions the corrosion of exposed metal may be attributable generally to one or more of the following causes:—

Concentration-cell Effect.—From a purely theoretical point of view it is possible to take exception to the term " concentration-cell effect," since the corrosion may be due to secondary influences of the soluble salt concentration, but for practical purposes it is a convenient means of referring to the corrosion usually associated with the highly soluble-salt soils. A buried pipeline runs through many varying types of soil, and the changes in the concentration of soluble salts from point to point result in concentration-cell effects. Soils containing a high percentage of soluble salt will tend to cause corrosion, while those of low soluble-salt content will become cathodic and therefore protective. Whether a pipe in a soil of medium soluble-salt content will corrode depends upon the uniformity of the soil and the nature of the other soils adjacent to it. Anodic areas, which are usually small compared with cathodic areas, result in pitting of the metal adjacent to good sections of pipe. In desert areas such as those experienced in the Middle East, the concentration-cell effect represents a principal cause of pipeline corrosion, since salt tends to be concentrated in patches of high-salt soils in a much lower salt-soil matrix.

Electrolytic-cell Effect (*Stray currents*).—Electrolytic-cell corrosion may result from a variation in the potential of the buried pipeline relative to the soil, caused by stray direct currents. Earth returns on electrical systems may result in the current following the line of lowest electrical resistance, which may be that of a pipeline or other buried or submerged structure.

Galvanic-cell Effect. — Galvanic-cell corrosion may occur when dissimilar metals are in contact, *i.e.*, when brass valves are fitted to steel pipes buried in soil; the portion of pipe close to the valves would become severely corroded. Galvanised pipe coupled to bare steel pipe results in rapid solution of the zinc coating. Because of the higher electrolytic solution pressure of zinc, its ions will go into solution. Where, for engineering reasons, different metals have to be used in a structure, galvanic troubles may often be overcome by the use of electrical insulation inserts, by the addition of inhibitors to the electrolyte, or by good coating protection. In galvanic-cell corrosion, films may form at either anode or cathode and these may stop continued corrosion, but this represents a secondary effect.

Bacterial Corrosion.—In desert areas, under dry aerated conditions, sulphate-reducing bacteria are dormant. In water-logged anaerobic conditions, however, these sulphate-reducing bacteria have the ability of reducing sulphates to sulphides, and of removing hydrogen from cathodic metal surfaces, and so allowing current to flow. Aggressive corrosion of buried steel and cast-iron pipes in the U.K. is largely attributable to sulphate-reducing bacterial activity. Vernon, Butlin, and Whiskin have shown that an alkalinity greater than *p*H 9 tends to inhibit the activity of sulphate-reducing bacteria, and since cathodic protection builds up alkalinity adjacent to the metal being protected, it tends to counteract the ravages of corrosion attributed to these bacteria.

Corrosion of Buried Metals

CATHODIC PROTECTION OF BURIED METAL STRUCTURES

By R. De Brouwer

Both theory and experiment show that buried metallic structures are immune from corrosion when they are sufficiently electro-negative with respect to their surroundings. This property of immunity of the cathode protects subterranean pipelines against corrosion caused by the aggressive nature of the soil, the heterogeneity of the metal, the formation of electro-chemical couples or by the electrolysis by stray currents. The various methods of protection, used separately or combined, are (1) polarised drainage; (2) forced drainage; (3) power-supplied systems, and (4) sacrificial anodes.

Very briefly it may be stated with regard to the first two methods that polarised drainage consists of neutralising stray currents by draining them through one, or more usually, several connections to the return circuits of electric traction lines. If the mean natural drainage current is insufficient to ensure the required minimum protection potential, it is necessary to apply an external electro-motive force. This means in practice that an electrical supply must be inserted in the drainage circuit which is then said to be forced. Tests have been established to determine the best method of cathodic protection in a particular case, and to assess the efficiency of the method.

Personal

MR. G. MCLAREN, M.B.E., Stenhousemuir, county convener of Stirlingshire, is to retire from the Carron Company, for which firm he has been employed as a heavy moulder since 1912.

MR. HAROLD S. HUTCHINSON, chairman and managing director of Douglas Elliot & Company, Limited, iron and steel stockholders, of Leeds, has been presented with a cocktail cabinet on completing 50 years' association with the company.

MR. R. A. R. BLACK, son of Prof. J. B. Black, of the Chair of History at Aberdeen University, has been appointed to the senior staff of the Bristol Aeroplane Company as project and aerodynamic engineer. During the war Mr. Black served with the R.A.F. as a pilot.

DR. E. C. S. MEGAW, newly-appointed Director of Physical Research at the Admiralty, was formerly the Superintendent of Research in the Admiralty Signal and Radar Establishment. After graduating from Queen's College, Belfast, Dr. Megaw was elected to a Beit Research Fellowship at the Imperial College, South Kensington. He joined the research laboratories of the General Electric Company, Limited, in 1930, working for 16 years under the late Sir Clifford Paterson and being awarded the Duddell Premium of the Institution of Electrical Engineers in 1933 for his work on methods of generating very short radio waves. A few years later Dr. Megaw undertook an investigation for the Admiralty into the possibilities of naval application of the shorter radio wave-lengths.

Obituary

A DIRECTOR OF Harold Gummer & Company, Limited, steel importers, etc., of Sheffield, Mr. George S. Sharman, died recently.

THE DEATH has occurred of Mr. William Inglis Dunlop, proprietor of Wm. Dunlop & Company, iron and steel merchants, of Glasgow.

THE DEATH has occurred, at the age of 63, of Mr. Harry Montague Mann, managing director of Whites Shipyard (Southampton), Limited, since 1944.

MR. WALTER HENRY BARTLETT, who was for 25 years general manager of the Sheffield works of James Fairley & Sons, Limited, steel manufacturers, until his retirement in 1947, has died. He was 78.

MR. ALPHONSUS QUIN, retired chief engineer officer with the B.I. Steam Navigation Company, has died in hospital at Campbeltown. He retired about four years ago. A native of Campbeltown, he served his apprenticeship as an engineer with the Clyde Building Company, Port Glasgow. Later he joined the B.I. and continued to serve them as engineer and chief engineer.

Recent Wills

CONNELL, R. D., a director of Magnesite Syndicate, Limited, London £39,381

DUNN, THOMAS, late chief buyer of the Consett Iron Company, Limited £5,188

PRICE, O. A., for 30 years chief hydraulic engineer with Glenfield & Kennedy, Limited, Kilmarnock £7,552

MATHER, EDWARD, managing director of Alexander Mather & Son, Limited, milling engineers, of Edinburgh £22,785

CRUSE, P. J., late deputy general works manager of Westinghouse Brake & Signal Company, Limited, London, N.1 ... ... £10,286

LINDLEY, SIR MARK FRANK, Comptroller-General of Patents, Designs and Trade Marks at the Board of Trade from 1932 to 1944 ... ... £10,733

RETALLACK, A. L., sales director of John Harper & Company, Limited, manufacturers of gas and oil appliances, etc., of Willenhall (Staffs) £42,873

SHEARER, WILLIAM, formerly chief cashier and accountant of C. A. Parsons & Company, Limited, engineers, etc., of Newcastle-upon-Tyne £12,909

HUTCHISON, ALEXANDER, a former chairman of Henry engineers, of Leven (Fife) who was elected an underwriting member of Lloyd's in 1924 ... ... £144,176

HEATH, A. W., chairman and managing director of Samuel Heath & Sons, Limited, brassfounders, etc., of Birmingham, and a former member of the Birmingham City Council £48,756

MILLS, H. C., managing director of the Morgan Crucible Company, Limited, London, S.W, chairman of Ship Carbon Company of Great Britain, Limited, and a director of Morganite Resistors, Limited £108,130

BATEY, DR. J. T., formerly managing director of R. & W. Hawthorn, Leslie & Company, Limited, marine engineers, shipbuilders, etc., of Newcastle-upon-Tyne, and a former president of the Shipbuilding Employers' Federation £88,441

HOLLAND, W. L., a director of W. L. Holland, Limited, agricultural engineers and brassfounders, of Preston, chairman of the Bury Ring Mill, Limited, and a member of the Preston Chamber of Commerce, and the Associated Chambers of Commerce £41,463

EVERARD, F. O., who started work with the foundry of Belliss & Morcom, Limited, the Birmingham engineers, as an apprentice at the age of 15 years, and eventually became works executive director, and who was one of the first owners of a steam-driven car in Britain £199,366

WOODALL, LIEUT.-COL. H. W., who in conjunction with the late Sir Arthur Duckham initiated the first experiments in the now world-known continuous carbonisation system known as the Woodall-Duckham system, and who was at one time chairman and managing director of Parkinson & Cowan, Limited, and a director of Newton Chambers & Company, Limited, and the Wellman Smith Owen Engineering Corporation, Limited... £97,839.

News in Brief

AN OLD CLYDE PADDLE STEAMER, built in 1888, which was used recently by the British Shipbuilding Research Association for experiments in marine jet propulsion, is to be scrapped at Faslane, on the Gareloch, by Metal Industries, Limited.

CORRESPONDENCE for Roe Bros. & Company, Limited, metal merchants and agents, etc., should be addressed to the company's new offices at 143/145, Norfolk Street, Sheffield, 1. The telephone numbers, Sheffield 25061-2-3, remain unchanged.

A COURSE of evening lectures on "The Corrosion of Metals" will be delivered by S. C. Britton, M.A. (Tin Research Institute), at the Northampton Polytechnic, St. John Street, London, E.C.1, on Tuesday evenings at 7 p.m., commencing on January 15, 1952.

THE ADDRESS of Percy Mason & Company, registrars of R. B. Pullin & Company, Limited, gyroscopic engineers, etc., of Brentford (Middx), as from December 20, will be 32, Queen Anne Street, Cavendish Square, London, W.1 (telephone: Langham 7616).

AT THE ANNUAL GENERAL MEETING of the British Steel Founders' Association held recently, Mr. T. H. Summerson, J.P., was elected chairman to succeed Mr. Frank Rowe, B.Sc. Mr. Summerson is chairman and joint managing director of Summerson's Foundries Limited of Darlington.

AT THE ANNUAL WORKS DINNER of W. H. Dorman & Company, Limited, Stafford, the chairman and managing director, Mr. H. F. Smallwood, mentioned that there had been a steady rise in output, and the order-books were full for two years ahead. The foundry output had increased by 12 per cent.

AT THE ANNUAL DINNER of the ambulance society of Hadfields, Limited, the Sheffield steel manufacturers, attended by Lord Dudley Gordon, the chairman, Mr. S. Leetch, the society's president, revealed that the company's ambulance room staff treated over 22,000 cases during the past year.

DISCOUNTING THE VIEW that there was a dark future ahead of the British locomotive-building industry, Brigadier J. Storar, chairman of Robert Stephenson & Hawthorns, Limited, Newcastle-upon-Tyne, said that the company had orders worth £2,500,000 which would keep the firm going well into 1954.

THE CLEVELAND BRIDGE & ENGINEERING COMPANY, LIMITED, Darlington, has received an order for a new 745-ft. bridge at Sydney Harbour, Australia. It will have six steel fixed spans and one opening span of 130 ft. Representatives of the company are already at Sydney arranging for the sinking of the necessary foundations.

PROPOSALS TO RECRUIT at least 100 more workers, mainly Italians, have been made by the Kettering Iron & Coal Company, Limited. The extra manpower would enable a newly relined furnace, which has been idle since May, to resume operations, with an increase in production estimated at between 1,000 and 1,200 tons of iron per week.

THE SIERRA LEONE DEVELOPMENT COMPANY has placed an order with the Birmingham Railway Carriage & Wagon Company, Limited, for three Diesel electric locomotives, for 3-ft. 6-in. gauge lines. They will be fitted with 1,000-h.p. engines supplied by Sulzer Bros. (London), Limited, and the electrical equipment is to be supplied by Crompton Parkinson, Limited.

THIRTEEN EMPLOYEES with 25 or more years' service of Hipkiss Bros., Limited, tube fittings makers, of Blackheath (Staffs), have been presented with gold watches in appreciation of their long service. At the same ceremony the founder of the firm, Mr. Harry Hipkiss, who was celebrating his 70th birthday, was presented with a set of cut glass by the workers.

FOLLOWING a two-months' visit to North America, Dr. K. Strauss, technical director of Foundry Services, Limited, is due to return to this country in the R.M.S. Mauretania, leaving New York on December 8. Dr. Strauss, as well as visiting a number of foundries, concluded arrangements in connection with the setting up of a new factory and laboratory at Guelph, near Toronto, Ontario.

CONTRACTS valued at more than £1,000,000 have been reported as having been received by Scotts' Shipbuilding & Engineering Company, Limited, Greenock. Orders are for two motor tankers—one of 12,000 tons and the other of 11,350 tons—for the Overseas Tankship (U.K.), Limited, London, and the Star Whaling Company, Channel Islands. Larger tankers will be fitted with steam turbines, and the second will have a Scott-Doxford oil engine, both being supplied by the builders.

A CAST-IRON TABLET, measuring 4 ft. by 3 ft., recording the first smelting of iron by the Whitby Iron Company, Limited, in the valley of the Esk in 1860, has been recovered from a Thornaby-on-Tees scrap yard. After cleaning the tablet is to be installed in Whitby Museum. The Whitby Iron Company, which was formed in 1858, had a short life, the works being offered for sale in 1861, but without result. Three years later there was a large-scale subsidence which filled in the mines at Scar Wood and the works never operated again.

FOUNDRY WORKERS employed by the Stanton Ironworks Company, Limited, will have two weeks' holiday next year. Also, plans have been completed for a new ablution centre, and a sports field at the Riddings works of the company. From December 17, retired employees are having their allowances increased by half. Mr. F. Scopes, managing director, recently presented four long-service certificates to employees who had completed 30 years' service with the firm, at their Riddings works, at a supper which was given by the Stanton Company to the Riddings Foundry Works Committee.

INTERESTING MEMORIES of the early history of the famous Soho Foundry were revived when, on December 14, gas-lighting was used for the last time in the streets of Smethwick, for it was there that the first gasholder in the world was built. William Murdoch, working for Boulton & Watt at the Soho Foundry, invented lighting by gas and carried out his experiments at the works and in the area. In the museum at Wednesbury is a piece of the earliest gas-piping in existence. Made by Murdoch at the foundry, it was taken from the floor of the house where he lived at Handsworth, Birmingham.

MR. P. G. GRIGG, chairman of the Midland Scrap Drive Committee, states that steel scrap drives are likely to be held in many of the large Midland towns early next year, after visits which representatives of the committee have paid to councils in seven counties. He disclosed also that during the past months the managements of many hundreds of factories have been interviewed and that, although the recovery of iron and steel resulting is appreciated by industrialists, an *intensive* search at one large factory had turned up 2,700 tons of scrap additional to the normal production scrap, a fact which seems to indicate that much recovery work has yet to be done outside production hours. With regard to farm scrap, which can yield a substantial quota of metal from old ploughs, harrows and machinery, Mr. Grigg believes that the urgent necessity is not yet fully appreciated and he anticipates an acceleration in the New Year in the drive in this field.

Company Meeting

Hale & Hale (Tipton) Limited

Steady Progress Maintained

MR. W. EDGAR HALE'S REVIEW

The fifteenth annual general meeting of Hale & Hale (Tipton), Limited, was held on December 19 at Dudley, MR. W. EDGAR HALE, M.I.Mech.E., M.Inst.F. (the chairman) presiding.

The following is an extract from the chairman's circulated review: Our trading during the year has been quite a successful one, and we have enhanced still further the already excellent reputation that our company has for its products.

Parent Company—The profit and loss account shows a trading profit of £89,963, as compared with £73,162, and there remains a balance of £36,147 representing the net profit for the year, an increase of £6,399. Your directors recommend a final dividend of 17½ per cent., less tax, making a total distribution for the year of 25 per cent., less tax, as compared with 20 per cent. for the previous year. This final dividend takes £9,188 and it is proposed that an amount of £20,000 be transferred to general reserve account to leave a balance to be carried forward of £12,958.

The consolidated trading profit for the year amounts to £120,077, as compared with £78,362; the consolidated net profit is £50,241, an increase of £13,506. After giving effect to the dividends already paid and the appropriations as recommended, there remains a balance of £16,878 to be carried forward, as compared with £27,204 brought forward.

Production, Sales, and Management

On our sales side, we are continuing to divide up our production by the exercise of the best method possible. Our Blackheart malleable iron castings, and also our new product which we are selling under the name of "Permalite," are exceedingly popular, and I do not think I am exaggerating the position when I state that there is nothing quite so good on the market.

Our products are supplied to almost every branch of the engineering industry, and it would be difficult to visualise any commercial organisation having a more secure foundation upon which to build its goodwill; thus one can be fairly certain that when one branch of engineering is having a lean time, some other section will be having the opposite.

With the rearmament programme, which is engaging our attention, the question of supply and demand is going to present an obstacle, but we are using our best endeavours to increase production, and for this purpose we visualise quite a considerable capital expenditure during the current trading year.

We have introduced during the year a very interesting appliance for materially improving upon the present method employed in the launching of ships. The first launch took place recently of an ocean-going oil tanker, and the result was excellent.

We are a well-balanced team, both in respect of management and production. The success of this enterprise is due to the energy and determination of everyone associated with it that makes it the powerful force it is in the industry to which it belongs.

It would appear as though the recent nationalisation of the iron and steel trade is to be revised, and that the industry will be returned, in some measure, to private enterprise. Although we are not directly affected by the nationalisation which took place, we are, in company with other like consumers of raw materials, directly dependent upon the nationalised industries for our main sources of supply, and therefore, personally, I am very glad of the prospect, for there is nothing to be gained and a great deal to lose under the present arrangement.

Current Outlook

Our financial position as a company is excellent, and is the outcome of taking much care of our finances for many years.

At this point one has to devote some attention to the question of "profit." The only real profit that the proprietors of any business secure is such an amount that is divided annually between them. The whole of the remainder is absorbed in the enterprise, to replace worn-out plant and buildings, and other contingencies which arise in the course of business. There are some people in the highest political spheres who are prepared to suggest that there is something definitely immoral about the making of profit. It is only out of profit that either our company or any other concern can build up a sound financial organisation. Taking our own position, for every £'s worth of value which we supply to our customers, 18s. 0½d. is absorbed in materials, wages, repairs, and overheads, taxation takes 1s. 2½d., and only 9d. remains as profit. It may be interesting to note that the amount paid in wages and salaries is approximately 10 times this figure of profit.

One cannot divorce the question of taxation from commercial finance, but the amount which is paid in taxation by industry today is just collossal and is, of course, a continual drain upon liquid funds; but there is nothing that can be done about it.

Since we became a public company I hardly think there has been a year where our trading has not been seriously affected by international disturbances, the high peaks of which, of course, were the years when we were actively engaged in war in Europe. It cannot but be felt that there must be some means whereby healthier counsels should prevail to bring to an end this atmosphere of continual cold war, and with a really "hot job" just round the corner carrying with it misery and disillusionment for millions of people. If war has to be, and we are called upon to play our part, you may rest assured that our company will undoubtedly give a first-class account of itself as it has done previously.

Raw-material Shortages

It is well known that world supplies of metallic ores, fuels, and all other basic materials are already in very short supply, due, in the main, to the over consumption of these supplies in the attempt to improve the standards of living everywhere. The present supplies are really insufficient to keep a first-class peace programme working to the full, so that the extra demand necessary for arms production is going to be exceedingly difficult to fulfil. It becomes self-evident that, as a nation, we are going to be deprived of some of the important necessities of life, and the consuming public have just got to suffer and put up with it.

Then there is the all-important question of fuel. We have, of course, suffered fairly considerable inconvenience at times in regard to supplies of solid fuel, gas, and electricity, and there is no gainsaying the fact that our national position in respect of these vital supplies is worsening, and here again, the solution is most difficult. The using of less fuel in producing finished articles has made some slight alleviation, and this process will be continuous; but it is all so slow. Nevertheless, it is at least a crumb of comfort.

In mentioning the very important adverse problems with which we are faced nationally, the inclination is to be pessimistic, but if we meet our troubles in the same bold spirit we have adopted in the past, I am sure we shall eventually reach a brighter period.

The report was adopted.

Raw Material Markets

Iron and Steel

The recently improved supplies of ore and coke are reflected in the pig-iron output figures for the month of November. It is the steelworks and not the foundries that are reaping the benefit of the increased pig-iron output, however, the former demanding more pig-iron in order to make good the acute shortage of scrap. The position is such, in fact, that there is a possibility that additional furnaces will be turned over to the manufacture of basic-steel making iron. Any further encroachment on the production of the foundry grades of pig-iron would have serious consequences.

Foundrymen's difficulties would, of course, be eased if additional furnaces could be brought into commission; these are available and are only idle because of the shortage of raw materials, particularly coke. The policy of the authorities is to give preference to the blast furnaces from available supplies of coke, but deliveries are not sufficient to enable them to extend operations. The foundries are also in need of larger quantities of coke; current deliveries generally cover immediate needs, but users' stocks are low and any interference in regular despatches, which must be expected at this time of the year, would have serious consequences for many establishments.

Conditions at the re-rollers show no improvement. They are dependent almost entirely on deliveries of semi-manufactured steel from home sources, and the steelworks themselves are working short time in their rolling mills owing to shortage of steel. Allocations to some re-rollers for this period have already been supplied from some home sources, and future working of their plants depends on their ability to obtain supplies from other home makers or from abroad. Foreign supplies, however, at present are negligible and many re-rollers are not receiving anything at all from oversea. Meanwhile, outputs of the smaller sizes of sections, bars, and strip are on a much reduced scale. Re-rollers are finding difficulty in fulfilling even the restricted export orders on hand.

Sheet re-rollers are also in need of larger quantities of sheet bars to enable them to clear off some of the arrears of work. The re-rollers will accept any material suitable for conversion and any tonnages of defectives and crops which arise are readily taken up.

Non-ferrous Metals

Statistics relating to October were issued last week by the British Bureau of Non-ferrous Metal Statistics and from these it can be seen that activity was well maintained. The cumulative total for copper usage over the first 10 months is 460,812 tons, which is about 32,000 tons up on the corresponding period last year. In October consumption amounted to 51,799 tons, of which 30,826 tons was virgin. In September the corresponding figures were 46,546 and 28,291 tons. Stocks of virgin copper dropped from 132,249 tons to 122,808 tons at October 31.

On the other hand, our reserves of lead advanced from 43,902 tons at October 1 to 47,522 tons at the end of the month. Consumption of all grades, at 29,964 tons, compared with 27,352 tons in the previous month.

Consumption of zinc, at 25,204 tons in October, was up by about 340 tons on September, while stocks of virgin at the end of October were about 150 tons up at 35,684 tons. In tin there was a fairly sharp drop in stocks from 1,803 tons at September 30 to 1,593 tons at the end of October. Consumption rose by 261 tons to 2,177 tons.

On December 12 the long-awaited Ministry of Supply Order fixing an upper limit for secondary copper ingots, wire bars, and cathodes, was issued, and the contents of the Order were very much as anticipated. The highest basis price allowed under the order is £225 10s., f.o.r., but there may be extras for shapes. Both fire refined and electrolytic quality are covered by the new regulations.

Again in line with expectations, the permitted maximum for copper scrap was brought down by £8 to £202 for the highest value in the list, with other types in proportion. Brass scrap, and other alloys of copper, as well as brass ingots and billets, have all been given new upper limits, the adjustment being £6 down in the 70/30 range and £5 down in the others.

The market in scrap has been quieter than usual due to the approach of the Christmas holiday and we must wait for the New Year to find out what the reaction to the new schedule is likely to be.

London Metal Exchange official tin quotations were as follow:—

Cash—Thursday, £927 10s. to £932 10s.; Friday, £930 to £935; Monday, £920 to £925; Tuesday, £912 10s. to £915.

Three Months—Thursday, £917 10s. to £920; Friday, £926 to £927 10s.; Monday, £922 10s. to £925; Tuesday, £907 10s. to £910.

Clerks and Draughtsmen Get More Pay

Almost 180,000 clerical and administrative workers will benefit from wage increases granted as a result of discussions between union representatives and representatives of the Engineering and Allied Employers' National Federation. Announcing this on December 6, the Clerical and Administrative Workers' Union stated that increases in the salaries of all workers of 21 years of age and over of 14s. a week for men and 10s. 6d. a week for women, with proportionate increases for juniors, would come into effect on December 10.

About 50,000 draughtsmen employed in the engineering industry, other than shipbuilding, received an increase of 14s. a week, with effect from that date, as a result of negotiations between the Engineering and Allied Employers' National Federation and the Association of Engineering and Shipbuilding Draughtsmen in London recently. The award will affect all draughtsmen over 21 years of age.

Vickers-Armstrongs African Representation

It has been announced by Vickers-Armstrongs, Limited, and Metropolitan-Cammell Carriage & Wagon Company, Limited, that they are reorganising their representation in South Africa as from January 1, 1952. At present both companies are represented in South Africa by Vickers & Metropolitan Carriage (South Africa), Limited, which as from that date will change its name to Vickers-Armstrongs South Africa (Pty.), Limited, and concurrently a new company, Metropolitan-Cammell Carriage & Wagon Company, Africa (Pty.), Limited, will be formed. Vickers-Armstrongs South Africa (Pty.), Limited, will sell the products of Vickers-Armstrongs, Limited, in South Africa and the Rhodesias, and will also represent Palmers Hebburn Company, Limited, and other companies in the Vickers group.

The directors will be Mr. D. W. Stanley, chairman and managing director, Mr. B. L. Blaine, Mr. W. H. Butler, Mr. J. A. Killick, and Mr. A. H. Hird.

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

(Delivered, unless otherwise stated)

December 18, 1951

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £11 10s.; Birmingham, £11 4s. 6d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £13 0s. 6d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £13 12s. 3d.

Scotch Iron.—No. 3 foundry, £13 1s., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £15 7s.; South Zone, £15 9s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £15 17s.; South Zone, £15 19s. 6d.

Cold Blast.—South Staffs, £17 5s. 6d.

Hematite.—Si up to 2½ per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. Coast and N.-W. Coast of England, £12 17s.; Scotland (Scotch iron), £13 3s. 6d.; Sheffield, £13 13s. 6d.; Birmingham, £14 0s. 6d.; Wales (Welsh iron), £13 3s. 6d.

Spiegeleisen.—20 per cent. Mn, £22.

Basic Pig-iron.—£11 15s. 6d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered.)

Ferro-silicon (6-ton lots).—40/55 per cent., £40 15s., basis 45% Si, scale 15s. 6d. per unit; 70/84 per cent., £56 2s. 6d., basis 75% Si, scale 16s. per unit.

Ferro-vanadium.—50/60 per cent., 15s. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 9s. 6d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £175; ditto, copper-free, £190.

Ferro-tungsten.—80/85 per cent., 33s. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 35s. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent C, £74, basis 60% Cr, scale 24s. 6d. per unit; 6/8 per cent. C, £70, basis 60% Cr, scale 23s. 3d. per unit; max. 2 per cent. C, 1s. 8¼d. per lb. Cr; max. 1 per cent. C, 1s. 8¾d. per lb. Cr; max. 0.15 per cent. C, 1s. 9½d. per lb. Cr.; max. 0.10 per cent. C, 1s. 9¾d. per lb. Cr.

Cobalt.—98/99 per cent., 17s. 6d. per lb.

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

Ferro-manganese (blast-furnace).—78 per cent., £40 8s. 9d.

Metallic Manganese.—96/98 per cent., carbon-free, £215 per ton.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £21 11s. 6d.; tested, 0·08 to 0.25 per cent. C (100-ton lots), £22 1s. 6d.; hard (0.42 to 0.60 per cent. C), £23 19s.; silico-manganese, £29 15s.; free-cutting, £24 15s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £27 16s.; case-hardening, £28 4s.: silico-manganese, £30 16s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £25 15s.; basic, hard, over 0.41 up to 0.60 per cent. C, £26 15s.; acid, up to 0.25 per cent. C, £28 4s.

Sheet and Tinplate Bars—£12 16s.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £25 6s. 6d.; boiler plates (N.-E. Coast), £26 14s.; chequer plates (N.-E. Coast), £26 15s. 6d.; heavy joists, sections, and bars (angle basis), N.-E. Coast, £23 15s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £27 11s.; flats, 5 in. wide and under, £27 11s.; hoop and strip, £28 6s.; black sheets, 17/20 g., £35 15s. 6d.; galvanised corrugated sheets, 17/20 g., £49 18s. 6d.

Alloy Steel Bars.—1-in. dia. and up: Nickel, £44 17s. 3d.; nickel-chrome, £65 2s. 9d.; nickel-chrome-molybdenum, £72 10s. 3d.

Tinplates.—52s. 1½d. per basis box.

NON-FERROUS METALS

Copper.—Electrolytic, £227; high-grade fire-refined, £226 10s.; fire-refined of not less than 99.7 per cent., £226; ditto, 99.2 per cent., £225 10s.; black hot-rolled wire rods, £236 12s. 6d.

Tin.—Cash, £912 10s. to £915; three months, £907 10s. to £910; settlement, £912 10s.

Zinc.—G.O.B. (foreign) (duty paid), £190; ditto (domestic), £190; "Prime Western," £190; electrolytic, £194; not less than 99.99 per cent., £196.

Lead.—Good soft pig-lead (foreign) (duty paid), £175; ditto (Empire and domestic), £175; "English," £176 10s.

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £211 10s.; rolled zinc (boiler plates), all English destinations, £209 10s.; zinc oxide (Red Seal), d/d buyers' premises, £205.

Other Metals.—Aluminium, ingots, £124; antimony, English, 99 per cent., £365; quicksilver, ex warehouse, £73 to £73 10s.; nickel, £454.

Brass.—Solid-drawn tubes, 25d. per lb.; rods, drawn, 32⅝d.; sheets to 10 w.g., 30⅛d.; wire, 31¼d.; rolled metal, 28¾d.

Copper Tubes, etc.—Solid-drawn tubes, 26d. per lb.; wire, 254s. per cwt. basis; 20 s.w.g., 281s. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £245 to £280; BS. 1400—LG3—1 (86/7/5/2), £260 to £300: BS. 1400—G1—1 (88/10/2), £330 to £360; Admiralty GM (88/10/2), virgin quality, £330 to £360 per ton, delivered.

Phosphor-bronze Ingots.—P.B1, £340 to £370; L.P.B1, £295 to £315 per ton.

Phosphor Bronze.—Strip, 38½d. per lb.; sheets to 10 w.g., 40¾d.; wire, 43½d.; rods, 38½d.; tubes, 36½d.; chill cast bars: solids 4s., cored 4s. 1d. (C. CLIFFORD & SON, LIMITED.)

Nickel Silver, etc.—Ingots for raising, 2s. 7½d. per lb. (7%) to 3s. 7½d. (30%); rolled metal, 3 in. to 9 in. wide × .056, 3s. 1½d. (7%) to 4s. 1½d. (30%); to 12 in. wide × .056, 3s. 2d. to 4s. 1⅝d.; to 25 in. wide × .056, 3s. 4d. to 4s. 3⅜d. Spoon and fork metal, unsheared, 2s. 10⅜d. to 3s. 10½d. Wire, 10g., in coils, 3s. 7¾d. (10%) to 4s. 7½d. (30%). Special quality turning rod, 10%, 3s. 6¾d.; 15%, 3s. 11½d.; 18%, 4s. 3⅜d. All prices are net.

Board Changes

DENNIS BROS., LIMITED—Mr. V. W. Pilkington has resigned from the board.

GEORGE WIMPEY & COMPANY, LIMITED—Mr. R. Grant has resigned from the board.

CROSSLEY BROS., LIMITED—Mr. Hugh Beck has been appointed an additional director.

LION FOUNDRY COMPANY, LIMITED—Mr. David C. Miller has been appointed a director.

HENRY MEADOWS, LIMITED—Mr. E. J. Batchelor, a director and general manager, has been appointed managing director.

MINWORTH METALS, LIMITED—Mr. Hugh Wylie has resigned and the board has co-opted Mr. FitzHerbert Wright to fill the vacancy.

R. W. HAWTHORN, LESLIE & COMPANY, LIMITED—Mr. John Bulman, general manager of the company's marine engine works, has been appointed a director.

NATIONAL GAS & OIL ENGINE COMPANY LIMITED—Mr. Joseph Jones has been appointed managing director and Mr. C. F. Barnard has succeeded him as general manager with a seat on the board.

TRIPLEX FOUNDRY, LIMITED—Following the recent death of Mr. H. E. Hind the new board will consist of Mr. J. W. Horrell, chairman and joint managing director, Mr. C. P. Horrell, joint managing director, and Mr. F. H. Bennett.

MR. CHARLES WILLIAM SCAMMELL, secretary of Harland & Wolff, Limited, shipbuilders, Southampton, since 1929, has retired after 44 years with the company. He joined the Southampton branch of the company on its establishment in 1907. MR. D. BARCLAY, of the Belfast staff, has been appointed to succeed him.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained.

BIRKENHEAD, January 14—Steel fabric reinforcement, iron castings, miscellaneous wrought iron, etc., for the Borough Council. The Borough Engineer and Surveyor, 3, Conway Street, Birkenhead.

ELLAND, January 12—Cast-iron gully grates and frames, etc., for the Urban District Council. Mr. F. R. Birkhead, engineer and surveyor, Council Offices, Elland.

HARROW, January 4—Road castings, for the Urban District Council. The Engineer and Surveyor, Council Offices, "Cottesmore," Uxbridge Road, Stanmore.

MAIDENHEAD, January 5—Cast-iron goods, for the Borough Council. Mr. C. T. Read, borough engineer and surveyor, 14, Craufurd Rise, Maidenhead.

NEWPORT, MON, January 5—Cast-iron gully grating and frames, for the County Council. Mr. R. Cornish, county engineer and surveyor, "Stelvio," Bassaleg Road, Newport (Mon).

SLEAFORD, January 1—Gully grates and frames, etc., for the Lincolnshire County Council The County Surveyor, County Offices, Sleaford.

BELFAST, January 4—Supply and erection of two sets of condensate chemical treatment plant for turbo-alternators, for the City Council. Merz & McLellan, consulting engineers, Carliol House, Newcastle-upon-Tyne, 1. (Deposit, £5 5s.)

Changes of Name

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

COVENTRY METAL PROTECTION, LIMITED (Coventry Industrial Components, Limited).

JOHN BROWN & THOS. FIRTH (OVERSEAS), LIMITED, London, S.W.1 (John Brown & Company (Overseas), Limited).

THOMSTER PRODUCTS, LIMITED, iron masters and founders, etc., of Biggleswade (Beds) (T. E. Thomas & Company, Limited).

CLASSIFIED ADVERTISEMENTS

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

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

SITUATIONS WANTED

FOUNDRY METALLURGIST, B.Sc., requires executive position. Experienced in grey iron and malleable. Foundry and laboratory control. Anywhere.—Box 1448, FOUNDRY TRADE JOURNAL.

AGENCY, Office Management.—Retired Manager, Grey and Malleable Ironfoundry, for London and South; fully qualified Metallurgist.—Box 1421, FOUNDRY TRADE JOURNAL.

FOUNDRY MANAGER wishes to hear of vacancy, having several years of practical experience on all types of motor and motor cycle castings. In High Duty Grey Iron Aluminium and Blackheart Malleable. Can be released by agreement from present position by Christmas. Can supply first class references.—Box 1452, FOUNDRY TRADE JOURNAL.

FOUNDRY / GENERAL MANAGER (age 45), M.I.B.F., A.M.I.P.E., life experience, grey and malleable jobbing, semi, full mechanisation, specialist repetition, auto-cylinder, etc., commercial, sales, excellent trade contacts, fully conscientious to development, organisation, practical man, metallurgist, sand, metal control, etc., able to get results through experience, desires change to small Midland foundry, with prospects of directorship on salary/results basis. Post must be capable of at least £1,500-£2,000 p.a. Strict confidence. —Box 1446, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

MOULDERS. — Jobbing Moulders required for Iron Foundry; rate 3s. 6d. per hour, plus £2 week bonus, plus merit bonus. Also all classes of Foundry Labour. —P.M.A., 136, Bramley Road, W.10. LAD. 3692.

GRAVITY DIE-CASTING FOREMAN required, Light Alloy Foundry, Bristol area. Possible assistance on housing.—Applications, stating age, experience and salary required, to Box 1449, FOUNDRY TRADE JOURNAL.

FOREMAN required for small partly mechanised foundry, also plate and loose patterns, one accustomed to Rate Fixing, able to work on floor, for firm engaged on Ranges, Grates and Engineering Castings, "Baxi" Patent Fires and Products; small house will be found if required. Apply in writing, stating full particulars, age, wage required and experience.—RD. BAXENDALE & SONS, LTD., Engineers and Ironfounders, Albert Street, Chorley.

A DIE DESIGNER for Gravity Die Casting is required by well-known Firm of Aluminium Founders in London area. Applicant must have had wide experience of modern gravity die technique and be able to supervise design, manufacture and foundry operation. This is a staff appointment, pensionable, and carries a good salary, with excellent opportunity for advancement. Applicants should write, giving full details of experience and qualifications, which will be treated in strict confidence.—Box 1417, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

NON-FERROUS AND CAST IRON MOULDERS required. Good rates. Canteen, etc.—Apply S.E.M., Pitsea Street, Stepney, E.1.

SKILLED MOULDERS, PLATERS, TURNERS, BORERS, etc., required by Distington Engineering Co., Ltd., Workington, Cumberland.—For further particulars apply to the LABOUR MANAGER.

FERRANTI, LTD., have the undermentioned pensionable staff vacancy: A young ASSISTANT FOUNDRY METALLURGIST for development work. Candidates preferably not over 25 years of age, should have Higher National Certificate in Metallurgy or Licentiateship of the Institution of Metallurgists. Ref. J.D.Met.—Forms of application from MR. R. J. HEBBERT, Staff Manager, Ferranti, Ltd., Hollinwood, Lancs. Please quote reference.

WORKS ENGINEER aged between 30 and 45 required for a Steelfoundry in Yorkshire. A first class experienced person is required to take full control of steel foundry maintenance and future development. The applicant must possess drive and initiative and have good organising ability and only men with previous foundry experience should apply. Write giving details of experience to date with salary required, all of which will be regarded in the strictest confidence. A house will be found for the successful applicant.—Box 1431, FOUNDRY TRADE JOURNAL.

A VACANCY exists for a first class CHIEF METALLURGIST in a modern Steelfoundry. It would be preferable if the applicant had experience of converter and arc furnace practice together with a wide knowledge of steelfoundry practice. The position will only be filled by a person having had previous experience of modern practices and one having a practical and progressive outlook coupled with the ability to integrate research and development work into actual production. Please give, in confidence, full details of age, experience and salary required. Housing accommodation will be found if necessary for the successful applicant.—Box 1432, FOUNDRY TRADE JOURNAL.

REQUIRED, promptly, for re-organisation of old-established Yorkshire Ironfoundry, experienced and energetic FOREMAN (age 40 to 45), to control all operations from raw materials to finished castings. Tactful and used to rate fixing for piecework. Required to produce high-class castings for machine tools, tank plates, jobbing pipes up to 30 in. dia., and general engineering castings in a Foundry used to producing 2,000 tons per annum, but now working to only 50 per cent. capacity. The post would be permanent for the right man, with good house and Staff Pension Scheme. Preference will be given to a really first-class applicant with a commensurate salary.—Applications, giving full particulars of training, experience, and positions held, to Box 1425, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

METALLURGIST required to assist Foundry Manager in general administration of modern iron foundry. Must have sound practical experience of all aspects of foundry work. Salary £700-£800. Four-room maisonette available end of January.—ROBERT CORT & SON, LTD., Reading Bridge Ironworks, Reading.

A TECHNICAL REPRESENTATIVE well connected with the Foundry Industry is required by a well-known firm of manufacturers of Corebinders, etc., to cover London and the South-East. Ownership of a car will be considered an advantage, although not an essential.—Box 1444, FOUNDRY TRADE JOURNAL.

IRONFOUNDRY.—HEAD FOREMAN wanted for Foundry in London on small to medium sized jobbing work. Part plate production. Must have thorough knowledge of trade, including cupola management. Metallurgical knowledge not necessary. Previous experience essential. Rent free house with job.—Write, giving full particulars and salary required, to Box 1445, FOUNDRY TRADE JOURNAL.

METALLURGIST.—Senior Assistant required by William Mills, Ltd., Aluminium Founders, Friar Park Road, Wednesbury. Experience in light alloys and foundry work; knowledge of X-ray procedure an advantage; age preferably about 30.—Replies, in confidence, to MANAGING DIRECTOR.

TWO ASSISTANTS to Foundry Manager required in a modern mechanised and jobbing Foundry in South Wales. Applicants should be 25/30 years of age, with a practical Engineering and Foundry experience. Good prospects, with training for an Executive Position. Commencing salary according to experience and qualifications. —Apply, in writing, stating education, experience, qualifications, age, and salary required, to Box 1430, FOUNDRY TRADE JOURNAL.

FOUNDRY TECHNICIAN required for West of Scotland foundry. Capable of starting up own laboratory. Routine analysis of all materials and sand control. Applicant must have sufficient practical knowledge to apply results to casting production. Help given with housing if necessary. Commencing salary, £546 per annum. Write giving full details of age, education, training and experience to 07X6 WM. PORTEOUS & Co., Glasgow.

TECHNICAL ASSISTANT required for Metallurgical Research Department. Metallurgical experience essential and possession of Higher National or equivalent certificate desirable. Age about 21-23. —Apply in writing with full particulars to SECRETARY, Magnesium Elektron, Ltd., Lumm's Lane, Clifton Junction, Nr. Manchester.

METALLURGICAL CHEMIST required for routine analysis of Aluminium and Aluminium Bronze Alloys to A.I.D. Standards, also Physical Testing and Microscopic analysis.—Write to VOWLES ALUMINIUM FOUNDRY CO., LTD., Bank Street, West Bromwich, in the first instance.