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Steel Founders' Conference

If anybody expected the disclosure of startling economies at the second productivity conference organised by the British Steel Founders' Association, they were guilty of muddle-headed thinking. For an industry to increase its productivity, it is not merely a question of the installation of a new machine, a reorganisation or fresh process. All these have been done before with varying degrees of success. For lasting results, spread over the widest ground, there must be created and maintained a general realisation of what is involved and a universal desire to achieve success. We have been favoured with a verbatim report of the proceedings, and we believe that what has been accomplished is, by and large, a lucid exposition of the existing state of the art, science, and practice of steel founding, the potentialities of recent developments, together with some notes on the initial efforts made towards the solution of the problem.

It will be noted that we have stressed knowledge of the "existing state of the art," because one delegate was apparently unaware that chains had by law to be tested at definite intervals. We have experienced the same type of lack of knowledge by people who should know better. Not very long ago, at a public meeting, a foundry manager thought it would be a good idea to standardise pattern colours, being quite unaware that this had been done several years ago. A second speaker said it was about time that a unified system of costing for the foundry industry was instituted. He received much the same answer as the earlier contributor to the discussion. It must not be thought that those people are fools, but, on the contrary, they have, possibly through isolation, just not happened to hear of what ought to be general knowledge. There is much excuse for not being *au courant* with all the latest process and plant developments, for life is too short for their wholesale digestion; moreover, some have a greater opportunity for the acquisition of such knowledge than others. The third question of initial attempts at improvements clearly showed that those undertaken were done so by people who had mastered the first two aspects.

This conference was a truly representative cross-section of the steelfounding industry and included a strong delegation from the trade unions. These gentlemen were no less enthusiastic as to the benefits to be derived from increased productivity than the executives. The co-operative spirit they showed augurs well for the future conduct of the industry. There will be more meetings of this type, and background information will be acquired naturally during general conversations. There will be a need to disseminate knowledge on new developments, but we expect the reporting of application and the results obtained to occupy much more time than was possible during the conference under review. Yet, extensive as these might well become, the real index will be the yearly tonnage made and the opinion of the consumer as to its quality, serviceability and price *vis-á-vis* with competitive materials. Ancillary subjects, such as costing and selling, will have to be prominent, as there is still much ignorance amongst a large section of the personnel of the industry as to the part played by these. The best guarantee of full employment is the existence of the largest possible number of satisfied customers. By this, we do not confine our remarks to the individual, but the industry as a whole. We are satisfied that the Conference was an outstanding one, for it provided the fundamental basis upon which progress can, and must, be built.

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Fatigue Strength of Cast Crankshafts

Dr. H. R. Mills and Mr. R. J. Love have reported to the automobile division of the Institution of Mechanical Engineers the result of their researches undertaken at the Motor Industry Research Association on the fatigue strength of cast crankshafts. The conclusions they reached are set out below:—

(1) The nominal limiting bending stresses for the cast crankshafts are, very approximately, one-third of the limiting stress of the material determined on unnotched rotating-beam specimens cut from separately-cast bars, or about one-sixth of the tensile strength of the material. These values are very similar to those obtained for forged-steel crankshafts.

(2) The bending fatigue strength of the cast-iron crankshaft is unaffected by surface finish changes.

(3) The bending fatigue strength of the cast-iron crankshaft is influenced considerably by fillet radius. A change of fillet radius from 0.031 to 0.125 of the crankpin diameter produced an 85 per cent. increase of strength. Fillets undercut into the web face caused a considerable reduction of strength.

(4) Increase of crankweb thickness or breadth gives an increase of crankshaft bending fatigue strength, but the improvement is not as great as the resulting increase of crankweb section modulus. Above certain values, a greater web thickness or breadth gives only a very small increase of strength.

(5) Crankpin length does not influence bending fatigue strength.

(6) The introduction of lightening holes, below a certain size, results in an increase of bending fatigue strength, the optimum hole size being about 0.4 of the crankpin diameter for the crankshafts tested. A larger hole can also be used with very good results if it is made eccentric with the crankpin axis.

(7) An increase of journal overlap produces an increase of fatigue strength; but above a certain crankthrow, an increase of crankthrow, or increase of "negative overlap," also produces an increase of fatigue strength. With the present hollow shafts, a minimum crankshaft strength was obtained at an overlap of −0.15 of the crankpin diameter.

(8) The nominal limiting stress for the crankshaft is influenced considerably by the crankshaft size. Reducing all the linear dimensions of the crankshaft by one-half resulted in a 28 per cent. increase of nominal limiting fatigue stress.

(9) The variation of results obtained for a batch of castings of the same design demands that caution be exercised when comparing the estimated fatigue strengths of different designs. To obtain a more reliable value for the fatigue strength of a particular design it would be necessary to test considerably more than five specimens of that design.

10) Tensile and fatigue specimens machined from separately-cast test-bars do not necessarily give similar values to specimens machined from the crankshaft castings. From the small amount of data available, tests on specimens machined from separately-cast bars do not appear to be closely representative of the fatigue properties of the crankshafts. At the same time, tests on the specimens machined from the crankshaft castings are probably not representative of the fatigue properties of the crankshafts either, since these fatigue properties are dependent on the properties of the material near the surface.

(11) It is considered that conclusions 4 to 7 are equally applicable to forged-steel crankshafts.

Plaster in the Patternshop

By "Chip"

Plaster of paris, or a similar material, is used extensively in some patternshops, while in others it is rarely if ever employed. An interesting use of this patternmaking material is for making master core-box patterns from which metal core-boxes can be prepared.

Especially is this of value when the cores are of an intricate nature, such as, for example, parts and valve pockets of various types of cylinders, cylinder heads, and the like, when the drawing only indicates the shape of the ends of the core and the mid-portion changes considerably, making it a difficult task for the patternmaker to obtain the correct shape throughout. Invariably, such cores must give an even thickness of metal around a water jacket or some other core and even when the utmost care is exercised in carving the wood core-box, and despite testing with a number of templates, discrepancies in metal thickness occur.

A far better method of producing such boxes is to prepare a model of the required core in wood—which incidentally can be carved far easier than its reverse in a core-box, and modified quicker if needs be. This model is then assembled in a mould and the metal thickness is checked. When satisfied that the wooden model is exactly as the core should be for shape and size, a mark is made on it corresponding to the core-joint. The model is then coated with oil and plaster is used to form a pattern of each half of the required core-box. When dry, the back of the plaster is relieved, so as to produce a lighter box when it is ultimately cast in metal.

The amount of contraction of the metal is sufficient to compensate for the amount of material removed from the metal box by filing or scraping. When complete, the core-box will be found to be far superior to one produced from a wooden master which has been carved from the solid.

The Government of India has recently modified the duty on aluminium manufactures, namely:—Plates, sheets, strips and foil, including foil in any form or size ordinarily used as parts and fittings of tea-chests, from 30 per cent. *ad valorem* plus Rs. 121 per ton to 30 per cent. *ad valorem* plus Rs. 46 per ton. The duty on aluminium in any crude form, including ingots, bars, blocks, slabs, billets, shots and pellets will henceforth carry an addition, per ton, of Rs. 237 instead of Rs. 328, while the *ad valorem* duty of 30 per cent. remains the same.

Spheroidal-graphite Cast Iron*

Some Properties and Applications

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

From a review of the information available at this time, it is clear that data on the properties of the new cast irons are both scattered and suffer from many omissions. In this review, therefore, the Author has attempted to collect and summarise the published figures, and to add new data now available from the practical experience of the magnesium process gained in the laboratories of The Mond Nickel Company, and through their development work in foundries. In particular new information is now presented on some of the more specialised properties of spheroidal-graphite cast iron.

SINCE THE development of cast iron with the graphite occurring in the spheroidal form in the as-cast state was announced some two years ago, a very great deal of information has been published on all aspects of this subject throughout the world. A complete bibliography of all that has been written by metallurgists and foundrymen in this connection now runs to over 150 items and is increasing month by month: consequently, the Author is faced with a difficult task in his endeavour to present something original, and his effort has been rendered even more difficult by the appearance of further important and comprehensive articles on this subject since the date when this Paper was undertaken.

As far as applications are concerned, there is no doubt that the development of spheroidal-graphite cast iron will go a long way towards revolutionising and extending the use of cast iron. It must be realised, however, that the new types of cast iron are essentially different in their properties and characteristics from any previously known metal, and, consequently, at present only a limited number of applications are established, and for the most part the uses of the new iron must be regarded as experimental and exploratory. A considerable time, perhaps even years, may have to elapse before the potentialities of the new material become fully realised. Many hundreds of tons of spheroidal-graphite iron castings have been made at home and abroad, and are now under observation in service under many different conditions. Reference is made in this Paper to some of the types of castings which have been made to date in spheroidal-graphite cast iron, and to their future possibilities.

TYPES OF SPHEROIDAL-GRAPHITE CAST IRON

The development of cast iron in which the graphite assumes the spheroidal form in place of the normal flake variety as a result of additions of cerium or magnesium has been described fully elsewhere (see, for example, References numbered 1, 2, 3 and 4). It has been shown that, as would be expected, and indeed as has been anticipated by many prominent metallurgists, the properties of iron castings can be improved to a remarkable degree by the modification of the graphite to the spheroidal form. This modification can be effected in grey cast irons possessing all the usual matrix structures, that is, ferritic, pearlitic, martensitic, acicular and austenitic, and further, the irons can be heat-treated to give either all ferrite structures by breakdown of pearlite on annealing, or the usual structures resulting from quenching and tempering. Again, as in other cast irons, the properties are influenced by composition; for example, phosphorus has its normal effect in weakening and embrittling the metal, and should be restricted to the smallest possible percentage. In addition, the properties of these new irons may be varied as a result of alloying. The collection of data covering the precise properties of all the different classes of spheroidal-graphite cast iron presents, as will be appreciated, very considerable difficulty, and even to-day, only part of the story can be told.

It would perhaps be best to make it clear at this stage that throughout the Paper the Author is using the term spheroidal-graphite cast iron to define cast iron containing graphite which is roughly spherical in shape, and which, as shown in the literature, is normally characterised by a radial crystalline structure. It is as well to emphasise that in discussing in particular the magnesium process,† the term nodular graphite is, in the Author's view, to be avoided, more especially since the term nodular is recognised in the malleable industry as generally defining aggregates of fine-flake graphite, a type which is very different from that developed in the irons under consideration. It should be noted further that in both the cerium and magnesium processes, a considerable improvement in the mechanical properties of cast iron may be developed with amounts of the additions insufficient to produce a fully spheroidal-graphite structure. It,

* A Paper presented at the Annual Conference of the Institute of British Foundrymen. The Author is on the staff of The Mond Nickel Company, Limited, London.

† British Patent No. 630,070.

nodularny = drobnopłatkowy

TABLE I.—*Comparison of Properties of Cast Irons with Flake and Spheroidal Graphite*

Matrix.	Graphite form.	Tensile strength, tons per sq. in.	Yield point, tons per sq. in.	Trans. rupture stress, tons per sq. in.	Elongation per cent.	Brinell. Hardness	Impact (unnotched) relative values.	Remarks.
Pearlitic ..	Flake ..	20 to 23	—	45	Nil	220 to 250	1	B.S. 1452 Grade 20.
	Nodular ..	30 to 50	22 to 35	—	Up to 5	180 to 220	5	High Mn Pearlitic Malleable.
	Spheroidal	35 to 45	25 to 33	60	1 to 3	230 to 280	3 to 5	
Ferritic ..	Flake ..	8 to 12	—	—	Less than 1	100 to 140	1	Annealed Grey Iron.
	Nodular ..	22 to 25	14 to 16	—	12 to 18	110 to 120	10 to 15	Normal Blackheart Malleable.
	Spheroidal	30 to 35	20 to 25	55 to 60	10 to 20	140 to 180	10 to 15	
Acicular ..	Flake ..	26 to 36	—	—	Nil	250 to 350	2	B.S. 1452 Grade 26.
	Spheroidal	40 to 60	30 to 40	—	Up to 5	250 to 350	—	
Austenitic..	Flake ..	10 to 14	—	—	1 to 2	140 to 200	6	
	Spheroidal	24 to 27	15 to 16	—	5 to 10	140 to 200	20	

therefore, becomes necessary to give some indication of what the Author has in mind in quoting properties for spheroidal-graphite cast iron. A first approximation in this connection is based on the assumption that to fulfil the definition, the structure of the iron should contain at least 90 per cent. of the graphite in the truly spheroidal form, and this is assumed in presenting the figures discussed below.

The general mechanical properties of spheroidal-graphite cast iron with pearlitic or ferritic matrices are now well-known and have been discussed at length in many of the Papers written on this subject. An early indication of some of the more specialised properties of irons made by the cerium process was given in the Paper by Morrogh and Grant[2] presented before the Annual Conference of the Institute in 1948. It must be pointed out, however, that in that Paper much of the work was carried out on irons in which the graphite was apparently not truly spheroidal, and many of the properties quoted are inferior to those expected from correctly made spheroidal-graphite irons. There is also evidence in the Paper that many of the irons tested contained substantial proportions of ferrite, and higher strengths are obtained when, as can readily be achieved in the magnesium process, the structure is predominantly pearlitic. The work reported by Morrogh and Grant is, however, important as giving an indication of the trend of improvement in special properties resulting from modification of the graphite form.

Mechanical Properties

Sufficient information is now available to develop a comprehensive review of the common mechanical properties of the spheroidal-graphite cast irons. These properties are summarised in Table 1, which includes irons with different matrix structures. For each structure a comparison is made between the spheroidal-graphite cast iron with corresponding types containing flake graphite, on the one hand, and nodular graphite as developed by heat-treatment in the malleable process, on the other. No place has been found in this table for whiteheart malleable cast iron, as it is felt that the low final carbon content of this product places it in a rather different class from the other irons indicated.

As would be expected from the information already available, the strength of the new cast irons is approximately 50 to 100 per cent. higher than that of the conventional materials, and this increase in strength is irrespective of the matrix structure of the metal. The figures given in the table are intended to compare the new class of irons with corresponding conventional types. Other authors have shown in detail the improvement in any one position resulting from the progressive modification of the graphite structure. The figures given support the view expressed widely elsewhere that the new iron will be of interest as a substitute for malleable, a point which is dealt with in more detail later. It will be realised, however, that the new type of cast iron does not in all respects provide an immediate substitute, and, as the new material has been studied in greater detail, fundamental differences have been realised, particularly with regard to the higher strength and lower ductility of the metal matrix. These properties are undoubtedly due to the strengthening of the matrix by the higher silicon and the presence of alloys in the spheroidal-graphite cast iron.

The figures shown in Table 1 are based mainly on published literature. They represent the range of properties which has been determined for spheroidal-graphite cast iron produced under a wide variety of conditions, using the magnesium process. In other cases, however, particularly with regard to the irons with acicular and austenitic matrices, the amount of data available is meagre, and the figures quoted are obtained from, in some cases, only a few tests. They are included, however, as it is believed that they may be taken as truly representative. More detailed comments on the properties shown in the table are, as follows:—

Tensile Strength:

The figures shown are well supported by published literature. Lower figures have sometimes been quoted, but a closer study in these cases invariably reveals that the graphite is incompletely spheroidised. The figures for the more specialised irons, such as the acicular and austenitic types will emphasise the point made above concerning the doubling of the strength irrespective of the matrix structure.

Yield Point:

Ordinary flake-graphite cast iron does not show a true yield in the tensile test. In the case of the new-type irons, however, the stress-strain curve in the tensile test assumes a straight line character for lower values of stress and demonstrates a distinct yield point. This feature proves the material to be different from ordinary iron in which no such feature occurs, and permits a more definite determination of elasticity. This figure is included, as it is realised it will be of interest and value to designers.

Transverse Rupture Stress:

Little information is available on this property, due largely to the difficulty of carrying out the transverse test on relatively small bars of ductile materials. Such figures as have been included in the table have been obtained from work carried out by Morrogh[5] on 3-in. diameter bars.

Elongation:

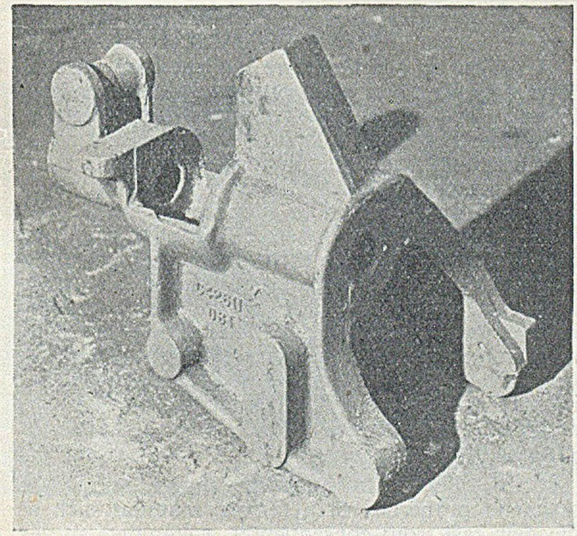
The figures for elongation shown in particular by the ferritic spheroidal-graphite cast iron are striking and reveal the fundamental difference between the new material and the conventional flake graphite cast iron. No more striking demonstration of the effect of flake graphite on the steel-like matrix of cast iron is given by any other property.

Brinell Hardness:

As for ordinary flake-graphite cast iron, the hardness varies widely with composition, and especially the use of alloys and the condition of the matrix as determined by casting conditions, heat-treatment, etc. The spheroidal-graphite cast iron is substantially harder than flake-graphite iron with the corresponding matrix structure, due to the denser form of the graphite. The presence of alloys, such as nickel, introduced as carriers for the spheroidising agent, also tends to raise the hardness. In spite, however, of the relatively high hardness of spheroidal-graphite cast iron, as shown in the Table, the machinability of the iron is good, as will be discussed later.

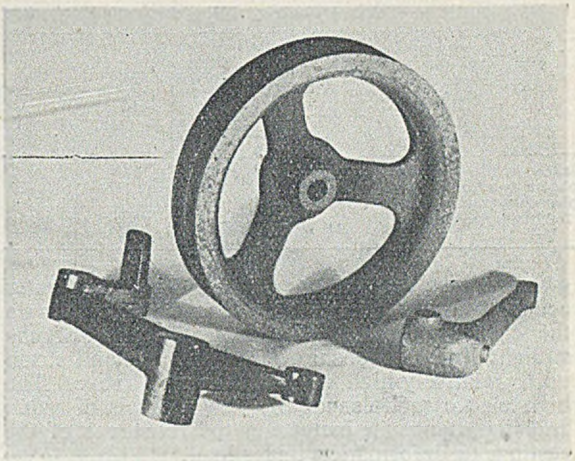
Impact:

It will be noted that relative values only are quoted under this heading, and these are for unnotched test-pieces. It has been necessary to quote



[Courtesy Lloyds (Burton), Limited

FIG. 1.—*Support Bracket for Agricultural Tractor in Annealed Spheroidal-graphite Cast Iron.*



[Courtesy Sheepbridge Stokes Centrifugal Castings Company, Limited

FIG. 2.—*Pulley and other Textile Machinery Castings in Spheroidal-graphite Cast Iron.*

relative values since no one single type of test adequately covers the range of impact resistance of the materials quoted in Table 1. Again, the figures which have been published by various authorities in different countries have been obtained using a variety of test-pieces, which render their inter-relation difficult, if not impossible.

The superior shock resistance resulting from modification of the graphite will be noted. In this connection, however, it has been found that, whilst the new cast irons show, as would be expected, a high degree of shock resistance when tested on unnotched bars, the same superiority is not always apparent when tests are carried out on notched specimens. Figures are at present limited and inconclusive on this point. In some cases notched impact resistance of an order expected from the data available on plain bars has been obtained, but in other cases the notched impact values have been appreciably lower due probably to the higher silicon and special alloys in the matrix of the metal.

Other Mechanical Properties

Table I lists the more common mechanical properties normally determined to evaluate the strength of grey-iron castings. Information on the less-frequently-measured mechanical properties of spheroidal-graphite cast iron is meagre, but in some instances information from a limited series of tests has been reported in the literature. This covers the following:—

Elastic Modulus

A figure of 25 million lb. per sq. in. has been quoted by Gagnebin and his co-workers.[6] They state that in addition this value is virtually unaffected by composition or section thickness, and is uniform from heat to heat. This fact is confirmed by such other information on elastic modulus as is available. Figures quoted by other authorities closely approximate to that given by Gagnebin. In this connection, it should be noted that the determination of the elastic modulus of spheroidal-

TABLE II.—*Comparison of the Steady Field Magnetic Properties of Flake-and Spheroidal-graphite Cast Irons.*

Material.	Initial permeability, μ_0	Maximum permeability, μ max.	Field strength for μ max. H. Oersted	Induction at field strength = 600 Oersted. B. Gauss	Induction at field strength = 75 Oersted. B. Gauss	Remanent induction for H max. = 75 Oersted. Br Gauss	Coercive force (to reduce B to zero) H_c) Oersted	Hysteresis loss for H max. = 75 Oersted Ergs/cc./cycle.	Steinmetz factor.
Flake-graphite cast iron	250	440	4.5	14,300	7,300	2,900	3.3	8,600	5.6×10^{-3}
Spheroidal-graphite cast iron (as cast)	75	425	12.0	16,000	12,100	6,000	7.5	28,000	8.0×10^{-3}
Spheroidal-graphite cast iron (after ferritising treatment)	—	1,400	3	16,000	13,100	3,600	2.0	7,300	1.9×10^{-3}

graphite cast iron can be carried out with greater accuracy in the case of the new materials than in the case of ordinary cast iron, in view of the straight line relationship between stress and strain up to relatively high values mentioned above. The high elastic modulus of the new irons is of value and importance in increasing the resistance of the castings to deformation under load.

Compressive Strength

In the same Paper,[6] Gagnebin and his colleagues have also studied the compressive strength of spheroidal-graphite cast iron and quote figures ranging from 55 to 80 tons per sq. in. according to the matrix structure of the iron. As emphasised in their Paper, however, these authors advise some caution in accepting these figures, since the compressive strength in a material of relatively high ductility is difficult to determine. If long test-bars are used, failure generally occurs by buckling, whilst with bars with a lower ratio of length to section, failure may never take place, and the specimen is merely squashed.

These authors quote a compressive yield strength of 26 to 40 tons per sq. in. for the as-cast specimens, and for the ferritic matrix annealed bars with a Brinell hardness of 195, a compressive yield strength of 29 tons per sq. in. is associated with an ultimate compressive strength of 55 tons per sq. in.

Fatigue Properties

In their original Paper[3] Gagnebin and his co-workers quoted some single results for the endurance properties of spheroidal-graphite cast iron. These gave a ratio of endurance limit to tensile strength of 0.44 for the iron as-cast, and 0.46 to 0.49 for the iron after annealing heat-treatment.

A more detailed study of endurance has been carried out by Eagan and James.[7] These authors carried out notched and un-notched endurance tests on sections cut from actual castings. This in part probably accounts for the fact that on the whole they quote lower endurance ratios than those given above, a typical figure being 0.34. Another possible factor is that the structures of the irons tested were not complete spheroidal. Their work emphasises that this ratio is similar to that for flake-graphite high-duty cast iron, but in view of the higher tensile strength of the new material, the actual endurance limit is substantially higher than anything previously available from cast iron. Another interesting point is that using notched specimens, the influence of the notch is far less marked with the new type of cast iron (as indeed it is with flake-graphite cast iron) than in steel, and in the notched test, the spheroidal-graphite cast iron actually has the highest endurance limit of all the materials tested. It seems reasonable to conclude from this that the endurance properties of the new cast irons compare very favourably with many steels, especially under notched conditions.

Variations in Structure

At this point it might be as well to give some attention to the question of the relationship between test-bars and actual castings. As with other types of cast iron, the structure of a particular casting is determined both by composition and cooling rate, the latter largely depending on section thickness. The matrix structure in turn determines the properties of the casting.

The relationship between test-bars and castings, and the variation between different section thicknesses in a casting has been studied.[8] It has been shown that the section sensitivity of spheroidal-graphite cast irons is, at least in the magnesium process, relatively low, and a high degree of uniformity of properties has been found in different sections of the same casting. Typical in this connection is a drop in tensile strength from 39 to 32 tons per sq. in. in a section increase from 1 to 6 in. It is reasonable to assume, therefore, that the properties noted above, and which for the most part have been determined on test-bars, are truly representative of the metal in sound castings in spheroidal-graphite cast iron.

Physical Properties

A review of the literature has revealed little information on the physical properties of the new cast irons. This is in spite of considerable interest which has been shown in such characteristics as the electrical and magnetic properties of the iron and their expansion characteristics. With regard to the last, there is no reason to suppose that the expansion characteristics of spheroidal-graphite cast irons differ substantially from those of the ordinary flake-graphite types. With the modification of graphite form, however, there was good reason to believe that there would be substantial modifications in the electrical and magnetic properties of the new irons. Some tests have now been carried out in the laboratories of The Mond Nickel Company and the first results are given below:—

Magnetic Properties:

It is difficult to quote in simple terms the magnetic properties of a ferrous material such as the new cast iron; consequently, a complete survey of the magnetic characteristics of a flake-graphite iron, and spheroidal pearlitic and ferritic cast iron was carried out. The results of this survey are given in full in Table II.

The magnetic properties were determined in a Hughes magnetic bridge permeameter. The results show that at low field strengths the flake-graphite iron gives larger values of permeability than the equivalent spheroidal-graphite cast iron. The initial permeability is more than three times that of the equivalent spheroidal-graphite cast iron, but the maximum permeabilities are about the same, though occurring at values of field strength which confirm that the flake-graphite iron is magnetically considerably softer. At 75 oersted the hysteresis loss of the spheroidal-graphite iron is 40 per cent. greater than that of the flake iron, but the permeability is more than 50 per cent. greater than that of the flake iron, facts for which no explanation is at the moment available.

Values of saturation induction for all the irons tested seem to be about the same, but the flake-graphite iron approaches saturation much more slowly and at 600 oersted, its induction is still less than 90 per cent. of the 16,000 gauss given by the spheroidal irons.

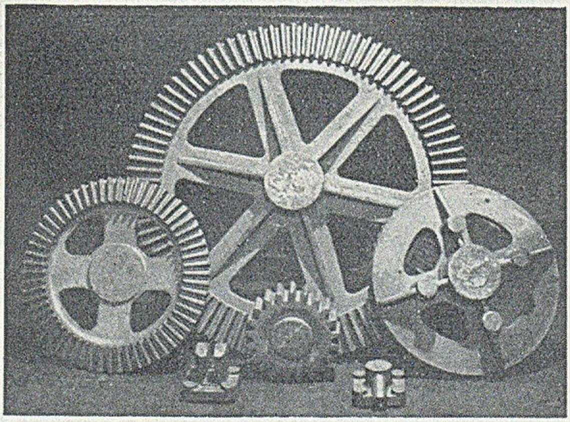
The ferritising treatment applied to the spheroidal-graphite iron improves by a factor of greater than three the important properties (excluding B max.) of the iron, *i.e.*, maximum permeability, coercive force and hysteresis loss.

The conclusions to be reached from these results are:—

(1) At low and intermediate field strengths the pearlitic spheroidal-graphite iron is inferior to the corresponding pearlitic flake-graphite iron.

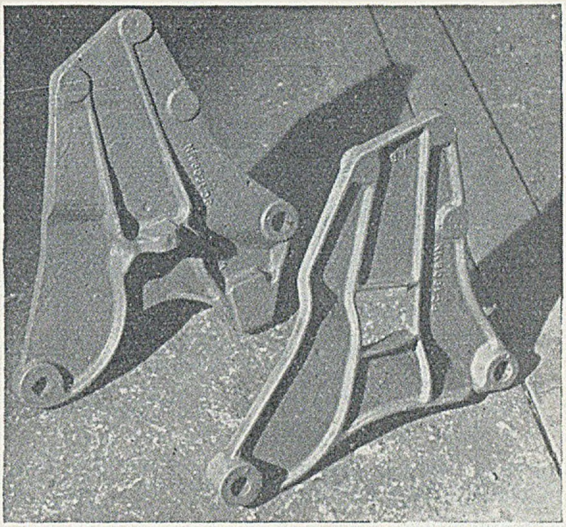
(2) At high field strengths, as used in d.c. power equipment, the pearlitic spheroidal-graphite cast iron is superior.

(3) The ferritic spheroidal-graphite cast iron is, as would be expected, superior in most respects to ordinary flake-graphite iron, and in this condition is of definite interest to the electrical engineer.



[Courtesy Robert Taylor & Company (Ironfounders), Limited

FIG. 3.—*Cast Gear and Sprocket Wheels and Small Castings in Spheroidal-graphite Cast Iron. The largest gear is 3 in. diameter and weighs 2½ cwt.*



[Courtesy Lloyds (Burton), Limited

FIG. 4.—*Plough Body Brackets in Annealed Spheroidal-graphite Cast Iron.*

Electrical Resistance:

The electrical resistance at room temperature has been determined on the cast irons tested for magnetic properties above. The results are as follows:—

Spheroidal-graphite cast iron—as cast: 57.6 microhms per cub. cm.

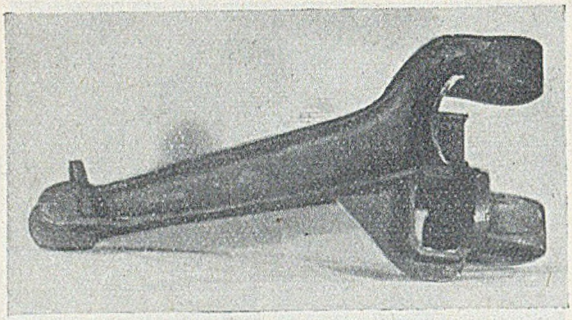
Spheroidal-graphite cast iron—after ferritising treatment: 54.8 microhms per cub. cm.

Flake-graphite cast iron—as cast: 106.6 microhms per cub. cm.

Since graphite has a much greater resistivity than iron, it will impede the current flow by an amount depending upon the projected area of the graphite at right angles to the direction of the current. Also, since spheres have a minimum area to volume ratio, it is not unexpected that the iron containing spheroidal graphite will have a lower resistivity than the more normal cast iron containing randomly orientated flakes provided that the volume of graphite is approximately the same.

Production Properties

This heading covers those properties which primarily interest the production engineer and which, in conjunction with the other properties discussed in this Paper, determine the choice of material and of design for particular applications. No consideration is given here to the foundry characteristics of the spheroidal-graphite cast irons, since these are outside the scope of the present review. It must, however, be emphasised that the experience now available in industry shows that the new type of cast iron can readily be cast into complex forms, using normal foundry methods, and is capable of giving regularly castings of dense and uniform structure. The new cast iron can, like its flake-graphite counterpart, be chilled to give white-iron surfaces where desired for maximum wear re-



[*Courtesy Sheepbridge Stokes Centrifugal Castings Company, Limited*

FIG. 5.—*Tractor Lift Arm in Spheroidal-graphite Cast Iron.*

sistance. Milder chilling conditions will give intermediate surface hardness.

Machinability:

The hardnesses of the spheroidal-graphite irons detailed in this Paper are relatively higher than for the normal class of casting. This characteristic is in part due to the presence of alloys, but there is evidence that, other things being equal, the form of the graphite itself has a definite effect in raising hardness.

The machinability of the spheroidal-graphite cast irons is good. As a result of the nature of the graphite, these irons machine more like steel than cast iron. Long continuous turnings are obtained: in fact, in one case a turning 13 ft. 6 in. long has been reported. Some detailed work on the machinability of spheroidal-graphite cast irons is reported by Gagnebin, and others.[6] The conclusion from tests in which tool life and power consumption were measured whilst turning three grades of spheroidal-graphite cast iron and, for comparison, a flake-graphite iron, led to the conclusion that, as far as tool life was concerned, the new iron with 220 Brinell hardness was equivalent to a soft, ordinary grey cast iron with a hardness of 143. When the spheroidal-graphite iron was annealed, however, to break down the matrix to ferrite, with a Brinell hardness of 170, tool life was 80 per cent. better than for the ordinary grey iron. On the other hand, the power consumption in the tests was about 40 per cent. higher for the spheroidal-graphite iron under conditions of equal tool life. This higher power consumption is undoubtedly related to the greater toughness and hardness of the spheroidal-graphite cast iron.

These observations have been confirmed by the experience of engineering firms in machining castings in the new iron. They report, in addition, that the quality of the machined surface is much superior to that of ordinary grey cast iron, and in fact more resembles that of steel.

Weldability:

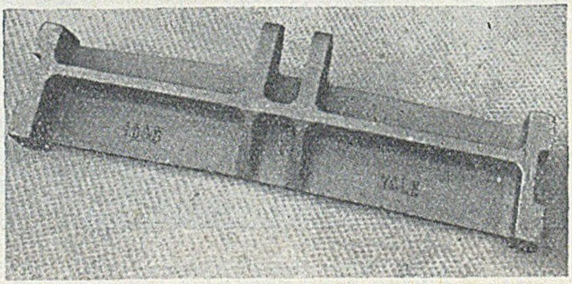
There are few data available on the response of the new cast irons to welding. Some information is, however, given by Gagnebin,[3] who states that the new material can readily be arc-welded, using modern technique and electrodes. Welding must, however, be undertaken with caution until more experience is available. It is stated, for example, that there are some indications of greater hardenability in the parent metal adjacent to the weld than is normal with ordinary cast iron.

Service Properties

Under this heading are included such items as resistance to the effects of wear, heat and corrosion. These are all characteristics which lend themselves only to a limited extent to evaluation by laboratory tests. Such tests, however, can give a useful guide to the probable behaviour of the metal in service. Service experience with the new cast irons is naturally still limited by the relatively short time in which castings have been under observation under working conditions. The following notes, may, however, be of value and guidance in considering possible applications of the new irons:—

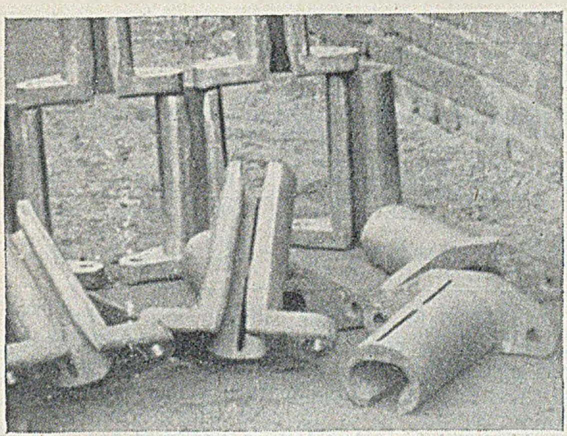
Wear Resistance:

Gagnebin and his colleagues[6] report work carried out in the laboratories of the International Nickel Company on the loads required to produce scoring and galling (seizing) for various types of cast iron, including spheroidal iron with pearlitic and ferritic matrices. It is perhaps difficult to assess the value of such tests in relation to the behaviour in service of, say, a Diesel cylinder or a lathe bed. These preliminary tests show, however, that the spheroidal-graphite iron is certainly not inferior to the established types of flake-graphite iron under the conditions of test. Only experience of the irons under service conditions will give a complete answer. There is, however, every reason to believe that the new irons offer great possibilities and can be applied with confidence where wear resistance is required. Due consideration must in this connection, of course, be given to matrix structure and for wear resistance, structures containing substantial amounts of ferrite should normally be avoided. It might have been anticipated that the spheroidal form of graphite was inferior to flake graphite in lubricating properties. First results, however, do not bear this out, and Vennerholm[10] has recently reported that the wear resistance of spheroidal-graphite cast iron under lubricated conditions is excellent.



[*Courtesy Lloyds (Burton), Limited*

FIG. 6.—*Check Beam for Lifting Truck in Annealed Spheroidal-graphite Cast Iron.*



[Courtesy Jadot Freres, Belgium

FIG. 7.—*Mine Cage Guide Brackets in Spheroidal-graphite Cast Iron*

Heat Resistance:

Once again there is very little information available and the only reference[3] to this subject shows that, as would be expected, the growth and oxidation resistance of the spheroidal-graphite cast irons are good. The irons are relatively stable under heat and the spheroidal form of graphite inhibits gas penetration and oxidation in the body of the metal, features which are basic to the growth of ordinary cast iron. The successful use of spheroidal-graphite cast iron for heat-resistance applications, is reported from the U.S., but final results are not yet available.

Corrosion Resistance:

Arrangements have been made in both the United States and in Great Britain for long-term service tests on spheroidal-graphite cast iron under conditions involving corrosion. Such tests naturally have to be extended over considerable periods of time, and it may be even a matter of years before results are available. In the meantime, short-time exploratory tests have been conducted in order to give an indication of the probable behaviour of the new iron when in contact with corrosive media.

Tests conducted in the laboratories of The Mond Nickel Company were made on materials

TABLE III.—*Percentage Composition of Irons Tested.*

Material.	TC.	Si.	Ni.	Mn.	S.	Mg.
Flake-graphite cast iron	3.5	2.55	0.73	0.49	0.009	—
Spheroidal-graphite cast iron	3.5	2.38	0.71	0.49	0.006	0.078

which included flake-graphite and spheroidal-graphite cast irons of approximately equivalent compositions. The object of this was, of course, to isolate the influence of graphite form. This involved the use of flake-graphite irons with compositions which were abnormal in some respects. The compositions are indicated in Table III. The abnormally low sulphur content should be particularly noted. It will also be seen that the flake-graphite iron contains 0.73 per cent. of nickel. This was an intentional addition to balance the nickel content in the spheroidal-graphite iron resulting from the use of the nickel-magnesium addition.

The spheroidal-graphite iron was tested as-cast, that is to say with a fully pearlitic matrix and after annealing to give a ferrite matrix. Corrosion tests were carried out on machined specimens in the following media:—

(1) 10 per cent. caustic soda solution at 50 deg. C.

(2) Sea water at room temperature.

(3) 10 per cent. ammonium sulphate solution at room temperature.

(4) 1 per cent. hydrochloric acid solution at room temperature.

(5) 5 per cent. sulphuric acid solution at 50 deg. C.

(6) 1 per cent. sulphuric acid solution at 50 deg. C.

All the solutions were air agitated.

Two series of corrosion tests were carried out. In series A, the specimens were exposed for an appropriate interval, after which loose corrosion product was removed by scrubbing with cotton wool under water. Afterwards, the specimens were returned for continued action. In series B, continuous immersion without disturbing the specimens was maintained for the time stated.

The results of the corrosion tests are contained in Table IV. The results are quoted in milligrammes per sq. decimeter per day (M.D.D.).

Unfortunately space does not permit the inclusion of all the details of these corrosion tests. The figures given, however, do show a clear indication of the trends. The complete results lead to the following conclusions:—

(1) On the basis of the limited data obtained from this investigation, in alkaline or nearly neutral media (in which corrosion was of the oxygen-absorption type), the spheroidal-graphite irons were similar or slightly inferior in corrosion resistance to the flake-graphite irons, depending on whether or not the coating of corrosion product formed was allowed to remain on the surface. Under these conditions it should be noted that the corrosion rates are low.

In slightly or moderately acid media in which corrosion was partially or completely of the hydrogen-evolution type, the spheroidal-graphite irons were superior to the flake-graphite irons. When the rates of corrosion in acid media were too high to be of wide practical interest, only the ferritic spheroidal-graphite iron showed to advantage among those under test.

(2) In 10 per cent. caustic soda solution at 50 deg. C. both types of cast iron formed an adherent hydrated oxide layer which prevented further attack. The thickness of hydrated oxide necessary to stifle attack was less in the case of the spheroidal-graphite cast irons than in the case of the flake-graphite cast irons.

TABLE IV.—*Corrosion Rate of Flake- and Spheroidal-graphite Cast Irons in Various Media, in Milligrammes per Square Decimetre per Day.*

Material.	Media.									
	10 per cent. caustic soda at 50 deg. C.		Sea water at room temp.		10 per cent. ammonium sulphate at room temp.		1 per cent. hydrochloric acid at room temp.		5 per cent. sulphuric acid at 50 deg. C.	
	Test A, 730 hrs.	Test B, 736 hrs.	Test A, 480 hrs.	Test B, 454 hrs.	Test A, 121 hrs.	Test B, 120 hrs.	Test A, 46 hrs.	Test B, 49 hrs.	Test A, 65 mins.	Test B, 3 hrs.
Flake-graphite pearlitic cast iron ..	3.3	3.7	55	48	167	124	5,950	5,600	300,800	231,300
Spheroidal-graphite pearlitic cast iron	1.3	2.5	69	49.5	145	85	820	1,087	186,500	246,700
Spheroidal-graphite ferritic cast iron	1.9	2.0	70	49.6	101	76	413	704	22,930	38,600

(3) Spheroidal-graphite cast irons suffered a greater attack by aerated sea water during the initial stages of corrosion, but after a rust coating developed, corrosion was controlled by the amount of oxygen reaching the metal surface and hence the rates of attack of both types of cast iron were similar.

(4) Spheroidal-graphite cast irons (particularly in the ferritic condition) were superior to the flake-graphite cast iron in resistance to corrosion by aerated 10 per cent. ammonium sulphate solution (pH 4.8).

(5) The results from corrosion tests in aerated acids are confusing, but it can definitely be stated that the spheroidal-graphite cast iron in the ferritic condition showed a marked superiority to the flake-graphite cast irons in the initial stages of attack. The formation of a graphite layer upon the surface of the cast irons as corrosion progressed tended to reduce the initial high rate of attack on the flake-graphite cast irons, but increased the comparatively low initial rate of attack on the ferritic spheroidal-graphite cast iron, and eventually the two rates become the same.

In considering these results, it must be noted that the composition of the flake-graphite iron was abnormal, and from the data available there is no doubt that the higher sulphur content of an average iron would cause it to have inferior corrosion resistance—thus showing the spheroidal graphite irons in an even more advantageous light.

This initial study of the corrosion resistance of spheroidal-graphite cast irons has been confined to irons with pearlitic and ferritic matrices. Work is in hand on spheroidal-graphite austenitic cast irons. Such irons appear to have very great possibilities where the well-known corrosion resistance of the austenite structure is required in combination with a cast material with mechanical properties at least twice as good as those of conventional Ni-Resist.

Bursting Pressure:

Some interesting information on the comparative behaviour of pressure castings in spheroidal-graphite and normal flake-graphite cast irons are given in the Paper by Eagan & James.[7] Test castings corresponding to pressure vessels were made in normal grey cast iron, special alloy iron, cast steel, and in spheroidal-graphite cast iron. The castings were tested to destruction, and the bursting pressures determined in each case were approximately proportional to the tensile strength of the metal.

Further data on this subject are given by Kuniansky[9] in connection with centrifugally cast-iron pipe with spheroidal graphite. In the case of all these tests, a notable feature is that the casting did not shatter, as is the case with normal flake-graphite cast iron, but bulged and split.

Surface Finishing:

Many queries have been raised by engineers and others interested in spheroidal-graphite cast iron as to its suitability as a basis for coated surfaces, *e.g.*, by plating, tinning or other methods which are well-known not to be entirely satisfactory on flake-graphite cast iron. No extensive information has yet been published in this direction, but preliminary tests are definitely encouraging, as might be expected in view of the dense structure and high degree of surface finish which can be achieved with the new irons, and there is every indication that they will prove markedly superior to ordinary cast iron for applications where such finishing is required.

(*To be continued.*)

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Refractories. Two leaflets have been received from the Morgan Crucible Company. Limited, of Battersea Church Road, London, S.W.11. One deals with a refractory concrete, whereby it is now possible for a foundry to make its own "specials," or Morgans will make them for the client. Its refractoriness is of the order of 1,520 deg. C. As a standby in any works this material should be handy. The second leaflet tells about cement, jointings, patchings, rammings and refractory cements available as fireclay, silliminite, fused alumina, pure alumina and silicon carbide. A very wide field is covered and some co-operation with the makers will be necessary.

Institute of British Foundrymen (Lancashire Branch)

Loam and Dry-sand Moulding in the Jobbing Foundry*

Discussion of Mr. D. Redfern's Paper

THAT A VERY hearty vote of thanks be accorded to Mr. Redfern for his exceedingly interesting and informative lecture, the subject matter of which was very dear to the heart of the practical foundryman, was proposed by MR. G. LAMBERT. Mr. Redfern, he said, had earned an enviable reputation in the foundry industry. He was, moreover, a Lancashire man who had been able to reverse the rôle of the traditional Scotsman who came to England but never returned to his native land with a view to resuming his business activities therein. In view of these high qualifications members had anticipated a good lecture and Mr. Redfern had met these expectations.

MR. H. P. HUGHES seconded the vote of thanks. Lancashire men were always keen to learn the views and the experience of men engaged in practical ironfounding. Personally, he felt very much indebted to Mr. Redfern for the information he had imparted by means of his Paper.

The vote of thanks was carried by acclamation.

Castings *versus* Weldings

Mr. Hughes said that Mr. Redfern had obviously had considerable experience of the competitive value of weldings *versus* castings. Personally he (Mr. Hughes) had also had some experience in that direction though mainly in connection with the smaller type required for the machine-tool industry. He did not think that the ironfounder had a great deal to fear in respect to the competition of weldings regarding the smaller type of castings as the former would be more expensive to produce. During the course of the war, and immediately subsequent to it, the industry was not able to cope with the requirements for castings, and therefore engineers had to look elsewhere for sources of supply. The alternative was welding, in respect to which difficulties had been encountered which had not been anticipated in this country or even as far afield as America . . . It was incumbent upon them to revert once more to iron castings whenever possible. He mentioned the point in the hope that Mr. Redfern could give some information with regard to the competitive value of iron castings as compared with the welded type of jobs which had been illustrated.

MR. REDFERN stated that he had already mentioned he was most interested in the one-off job, and particularly so when it ran from 2 to 40 tons. Previously, he had had experience of mechanised plant. As a matter of fact, he was engaged for 18 months at the Ford Motor Works at Cork before they were removed to Dagenham. The last slide (Fig. 27) had depicted a condenser weighing 9 tons. He had, however, never been able to obtain an accurate statement as to the relative costs of a casting and a welding, of similar design. In support of the contention that the jobbing foundry was losing ground to welding, he would mention that he had not seen or heard of a condenser body casting of this type being made in any foundry for years, yet he had seen dozens of fabricated condenser bodies in recent years. Some time ago, he had a shock when he saw one of the largest marine-engineering shops on the Clyde. For about 20 years, one of the specialities of the foundry where he was employed was the manufacture of single and double helical turbine gear wheels. These weigh from 19 to 26 tons each. On visiting these works mentioned he was surprised to see one of these helical gear wheels fabricated in mild steel—another instance where fabrication was being introduced in place of iron castings. In contradistinction, where a number of items was required, he doubted if the competition from welding and the like was really serious, as the cost of the castings was in this case less. Where the requirements were one- or two-off jobs, the cost of the casting plus patterns and core-box would be far higher than welding. A casting which would cost, say, £300 might carry as much again in addition for pattern equipment. This worked against the foundry when the engineer was making up his costs.

MR. H. HAYNES always felt it necessary to congratulate the loam moulder upon the efficiency with which he did his work, whether it was a large or a small casting. To make a casting was not as easy as it appeared to be, and the moulder could have many "headaches" in respect to vent holes, runners, lifting tackle, grids, and so on. It was all very well for engineers to come along with welding, but it was their downfall in the long run because the rigidness of an iron casting would outlast that of any welding.

At the present time he knew of some large welded 30 ft. long columns being made. They were insufficiently rigid in service, and it was necessary to add extra material to ensure strength, thus there was no need to be alarmed that welding would supersede cast iron. He was not going to heckle Mr. Redfern upon the method of making castings; probably every moulder had his own views upon individual methods. As a matter of fact, it did not matter how a casting was made, as long as it was a good one. The process should not be "rushed"; what was necessary was nerve, courage and confidence in undertaking the job,

* Paper read before the Scottish and Lancashire branches of the Institute of British Foundrymen, and printed in the July 7 issue of the JOURNAL.

Discussion—Loam and Dry-sand Moulding

and the adequate training of young entrants into the industry. Youths who now entered the foundry should be given every encouragement, and even if there was a difficult job in hand, they should be permitted to "have a go" at it. Even if one was turned out not up to standard the firm should pay for it, because the training of the youths was entirely in the interests of their employers. Good castings would not be made until the workman was able to discover the faults of the bad ones himself, and such knowledge was not gained in a few minutes.

Mr. Redfern emphasised that he did not present his Paper for consideration merely to impress his own particular views upon those who had heard it read. It contained an account of his own views, but if others did not think them to be right, he would be pleased to be told where they were wrong. A Paper should be criticised from a practical point of view.

Prior to 1939, three types of boys entered the foundry trade as apprentices (1) those who were sons of moulders and other foundry employees (2) those who due to economic circumstances entered the foundry as the only job available (3) those boys who were really interested in the foundry trade. The boys in the first two categories provided the bulk of the indifferent tradesmen—it was the last category which provided the best of craftsmen and executives. To-day with a wide choice of trades to choose from, few boys were entering the trade, those doing so were coming in because it was their own choice and a personal opinion was that these boys would be as good as, if not better, than the craftsmen of previous generations.

Ships' Castings

Mr. G. Lambert asked whether, in the marine world, it was weight rather than cost that was influencing welding.

Mr. Redfern pointed out that he knew very little of the technical side of ship construction or marine-engineering construction as such. Personally, he thought that except in the case of small cargo ships, the weight of the engine did not constitute a large factor in the shipbuilding estimate. He believed that modern designs of propulsion engines were as heavy as the old type of steam engine. There were many components which could be welded, but even the finest of them had not the same damping capacity as cast iron. The sooner it could be impressed upon the engineer that cast iron would absorb shock, rather than distort and jeopardise the machinery, the sooner they would get these castings back into the jobbing foundry.

In an engine room of a ship, everything was of a necessity rigidly bolted together. During the war, in the case of a "near miss" with an engine with a cast-iron bedplate, it was found the bedplate took the greater portion of the shock, and in many cases cracked, necessitating replacement. In a ship's engine with a fabricated bedplate, the bedplate did not crack, but distorted very badly and, due to this distortion, heavy damage to the crankshaft, bearings and other fittings was the consequence. In ships with the gearcase fabricated, this distortion caused serious damage to the gears. Despite this, marine engineers were still using fabrications in large quantities.

Running Methods

Mr. Haynes mentioned down runners on a casting illustrated. He noticed that some of the cross-sectional areas seemed to be larger than the troughs which lead to the down runner.

Mr. Redfern explained that the moulder had withdrawn the original tubes when putting on the grating. When the photograph came to be taken these could not be found. The tubes shown in the photograph were not the original tubes used, actually the diameter of the tube was $2\frac{1}{2}$ in., the troughs being $1\frac{1}{4}$ in. deep and $1\frac{1}{2}$ in. wide.

Mr. Haynes asked if there was sand sticking on the two cylinder castings or was there a scab or two.

Mr. Redfern replied that if there were a scab, the casting would be rejected. He thought he had mentioned that the castings shown were partly machined; where the cores were seen through the port holes, they carried straight through to the centre of the casting.

Mr. J. H. McMillan understood that what was referred to as a cross was used in strickling and that, if the job was off centre, a spindle was made and switched over to the second cross. Was it not possible to complete a strickling in each half of the mould separately, thereby saving much time?

Mr. Redfern then said the job could be done in that way but he did not consider it would save much time. It was far better to go round, particularly as the moulder had to put his building ring on for every course. He got his two building rings together and they were bound down together. Each building ring was cast in halves, these halves were later bound together. By this method the correct thickness of loam was assured to bed down each ring. To build each half of the mould separately would cause unevenness, with a possibility of the rings moving and causing cracks to appear on the face of the mould. As the metal contained about 30 per cent. steel, scrap cracks in the loam face would cause serious burning-in. The loam was made up of 15 per cent Scottish rotten rock sand, 5 per cent. pure clay and 20 per cent. sharp sand, the remainder being returned floor sand. It was mixed in an ordinary mortar mill, the Scottish rotten-rock sand was the best type of sand he had ever used in loam moulding. Despite its heavy clay content of $7\frac{1}{2}$ per cent. it did not silt readily and few cracks appeared after drying. No horse hair, manure or other binding material was used. All loam work was black-washed when "green." This was a practice new to the Author until working Scotland. All previous practice was to dry loam moulded work first and then dress and black-wash the face of the mould.

Moulding Sands

Mr. Haynes mentioned that the Manchester ship canal red sand was a useful sand.

Mr. Redfern said that the Scottish rotten-rock sand had something he could not explain. Put into the mill it could be as hard as a rock, yet with the addition of about 1 per cent. of water it crushed quite easily. The clay content was found in the centre of the rock, yet one did not get face scabbing that one would if one used the usual English sands. A common practice had been to use an addition of horse manure to prevent scabbing.

MR. R. S. YEOMAN thought the reference to loam-moulding sands was very interesting, loam-moulding having been discussed at the recent British Cast Iron Research Association Conference on Sands. One speaker had said he had extreme difficulty in making loam castings in Scotland, but whether the materials came from the district referred to by Mr. Redfern, he could not say. Nevertheless, it was the case that one or two individuals mentioned that they could not make castings in Scotland similar to those in England, mainly they said, because the sand was burned on.

While Mr. Redfern was speaking, a point had occurred to him with respect to the strickle board and skeleton pattern. He had some experience of making this particular kind of job and had invariably adopted the second practice mentioned by Mr. Redfern, that was, to build the cores first and to fix the branches round them. Everything else was set and the outside was built-up last. To his way of thinking, this was the most successful way of doing the job. He was interested in the running of the job described by Mr. Redfern. Personally he, Mr. Yeoman, did not understand how the runner box was used, but it would appear that Mr. Redfern lost control of the running of the job. Possibly he overcame that by designing a special runner.

MR. REDFERN was not prepared to comment on whether there were either good or bad castings made in Scotland. In his opinion, the skill of Scottish loam moulders was quite comparable with any there were in Great Britain, and as one who had travelled extensively throughout the British Isles, this opinion was based on experience.

Pattern Equipment

MR. W. HOLLAND observed that Mr. Redfern had shown in the case of the cylinder illustrated that a very poor pattern was provided. He presumed it was for a one-off job, because it was not very encouraging for moulders to use such a pattern.

MR. REDFERN answered that the pattern was not in much better condition when they first received it. It was the one job in the foundry which was not a one-off job. The equipment was supplied by an engineering firm which had taken over the foundry in order to enable them to make the castings for their own products. The heaviest casting required was three tons. With regard to the cylinder block, it was intended to make them by core-assembly methods which would avoid using a pattern and so make this a repetition production job.

MR. W. HOLLAND thought it would be of interest if Mr. Redfern would explain his method of core assembly in a steel frame. Mr. Redfern said he would endeavour to do so and drew a diagrammatic sketch on the blackboard. Mr. Redfern further remarked that he could complete cylinder blocks in 100 hours. This method had been adopted for a cast-iron bedplate, as Mr. Holland had already seen. The price for this particular bedplate using core-assembly methods would be about £15 cheaper than a welded job. See Fig. A.

MR. HAYNES said it was not quite as easy as it appeared to use a frame, because the three sixteenths machining allowance on all ports must be accurately adhered to. A governing factor, also, in fitting the part together was the arrangement of the vents. A skilled man must be engaged on arranging the venting. Much money would have to be spent in order to make so large a jig accurately.

Core-assembly Methods

MR. REDFERN thought that Mr. Haynes had misunderstood the point. There was no elaborate jig. In the normal way, the core-maker made the irons and rammed the job. Then the first thing he did was to get a big hammer and hit hard at the core-box to release the core. The result was that two cores were never alike. Even with a good core-maker, making the same core under this method, there would always be a difference in the two cores produced. With core-assembly methods, however, the ramming of the core was done by a machine.

A vibrator was attached to the machine and the core came smoothly away from the core box. Variations in cores made by this method were very slight. By means of plaster moulds, core driers were cast accurately to shapes, the cores were then placed in the stove and dried at an even temperature using thermostatic control. All cores were rammed by a Sand-slinger.

MR. P. HUGHES was not sure whether Mr. Redfern had adopted the cheapest method. Instead of using a Sand-slinger to make the cores, why not use it to make the mould, as core sand was a more expensive item?

MR. REDFERN said that part of his experience had been gained in one of the finest mechanised foundries in Europe while another experience was in a foundry producing air-cooled motor-cycle engines. There was a direct contrast between the two establishments. In the larger foundry, all production was from power-operated moulding machines. The smaller foundry used hand-operated moulding machines. The method of ramming up the motor-cycle engines was that the moulder threw the sand in by hand, gradually piling up the sand until it covered the whole of the pattern, backing sand was then used and rammed with a flat rammer. To use a pattern with a Sand-slinger, the pattern had to be specially constructed and possibly metal-faced to resist the wear of the sand. Using core-assembly methods, moulding labour was reduced. By assuring accurate design in the core-box construction, the method of building up the core-assembly was to set the side cores first and build-up the interior cores from this foundation. He had adopted this method to produce an eight-cylinder bedplate, the metal thickness varied between $\frac{3}{8}$ and $\frac{5}{8}$ in. and the casting was 9 ft. long. By the adoption of core-assembly methods, a reduction of 50 hours could be made on each casting. He agreed that pattern equipment was expensive. On these particular

Discussion—Loam and Dry-sand Moulding

items the provision of equipment might cost up to £1,500 but as these jobs were of a production nature, the amount involved could quickly be justified.

Mr. T. H. L. Bond remarked that there was a baseplate or a box and three sides bolted together. Did Mr. Redfern put the three side cores against the wall of the box with nothing in between? Mr. Redfern replied in the negative and again further explained the point by means of a diagrammatic sketch on the blackboard (See Fig. B).

Mr. Bond then asked if, when the loose piece was put on and the whole bolted up, was it lowered into a pit for casting?

Mr. Redfern replied that it was not. The cast-iron frame was about 2 in. thick. It would hold anything. As Mr. Haynes had remarked, the whole layout had to be dead accurate. It was like a series of building blocks.

It was not a new idea of his own. He saw an article in the American Press describing a bedplate weighing 215 tons made by a similar method. A moulder to make such a job was not available, so the firm made the mould by core assembly. It must have been an expensive thing to cast, and took from 2 to 3 months to complete. That was where the Author first visualised core-production methods. The expense of the cylinder layout would be recovered by lower production costs.

Comparison between Castings and Weldings

Mr. E. Longden said that in the full circle of the subject-matter dealt with by Mr. Redfern he had come round to the point of how easily he could compete with welding. To his, Mr. Longden's mind, welding had no place, finally, where the methods described by the lecturer were practised, namely, where loam, moulding, strickles, and only a small amount of tackle were concerned and which only the craftsman was permitted to use.

Reference had been made to a double-helical steel fabricated gearing, and how it was thought that the steel and the cast iron trades were going over to welded structures. There was, however, the cost of the casting to be taken into account, because unless the use of welded structures was bolstered up by some other department, the economic side of the job must be regarded as a matter of importance. So far as intrinsic properties were concerned, the structures obtained were not equal. For instance, the crystal formation formed on a casting produced a wear-resisting surface. It was known in the case of rolls, that by certain rates of cooling a "life" could be obtained from a casting which could not be equalled by any fabricated product. This was something which was still impressing the welding people, though they did introduce satisfactory welded parts with mild steel.

Mr. Redfern agreed with everything Mr. Longden had said. Marine engineers were the most conservative men in the trade on the one hand and yet most tolerant on the other. The fact remained that the engineer had made fabricated gear cases and that castings could show improvements.

He was speaking to an engineer recently about the use of nodular iron. He told him that there could be produced cast iron to give a tensile test of 45 tons per sq. in., but the reply was "who wanted it." That was the kind of mentality which had to be overcome. It had to be proved that cast iron was every bit as good as the welded component. On the other hand, there was in a few instances a shortage of work for skilled moulders because some jobs were being welded.

Mr. E. Longden commented that in regard to certain marine components the desired quality could not be obtained by welding.

Mr. G. L. Whyatt had had experience of welded structures being much dearer than castings, particularly in the steel-casting industry. He had also experience of extensive cavities in regard to welded gears after the gears had been cast on to rolled steel rims. It was understood that if there was a cavity in a steel casting it was beyond repair, but firms who had fabricated rolled rims were permitted to do repairs by welding.

Mr. Dawson, speaking with regard to welded structures *versus* casting, endorsed what Mr. Longden had said. He had seen relatively thin castings, quite simple jobs, really, which, after extensive machining, had proved to be faulty on pressure testing. He had read a Paper some time ago, mainly on castings for the shipbuilding trades, relating to turbine engines where the intrinsic qualities of, say, cast iron were better for the job. There was, however, such difficulty in getting the castings to withstand final pressure, that the people had gone over to weldings on that score alone.

There was the point of difference between the patternmaker and the moulder. The old argument was that the patternmaker made his job as he went along and the same consideration would appear to apply to weldings, particularly with larger types. A large casting, after much work had gone into it, might have to be scrapped for some minor defects, which, possibly, could be rectified by welding.

Influence of Design

Mr. Redfern agreed with much that Mr. Whyatt had said. He had made many big cylinders for the marine trade, and the reason he had raised the question of welded structures was in order to promote a full discussion. Mr. Longden had certainly provided a pointer as to the best course to adopt, namely, that good sound castings which would machine up properly must be produced. The greatest culprit of all was the designer and both he and the foundryman should get round the table and decide how to supply what was wanted. The aid of the metallurgist should be enlisted also. The designer might never have seen a foundry; though, more often than not, he was quite prepared to visit one and accept advice from the foundryman. That was the way to get good castings.

(*Continued on page* 71.)

Density of Radiographs*

THE RADIOGRAPHIC EXAMINATION of castings depends on the recording of the intensity of X-rays or gamma-rays transmitted through the specimens. Where defects occur, the transmitted radiation will usually be more intense than that which has passed through sound metal, although for certain defects (*e.g.*, some segregates), it may be less intense. These varying intensities result in areas of differing density in the radiograph, and hence in the production of images, the perceptibility of which depends on the differences in density and also on the sharpness of the boundaries. The density differences depend also on the characteristics of the various X-ray films. These are discussed below and practical recommendations are made.

In viewing a radiograph the eye perceives areas of differing brightness, more light being transmitted through areas of lower density. Film density is defined as

$$\log_{10}\left\{\frac{\text{Intensity of light incident on film.}}{\text{Intensity of light transmitted through film.}}\right\}$$

Thus, if the intensity is reduced to 1/100th of its original value, the density is

$$\log_{10}\frac{1}{0.01} = 2$$

As a very rough guide, it is possible to read newsprint through film of density approximately one, the film being laid on the page. An approximate measure of density may be obtained by visual comparison with films of known density or with a density step wedge. More accurate values are possible by direct measurement in densitometers, of which several commercial types are available. Important information about the performance of a radiographic film is obtained by giving it a series of different exposures to the same quality radiation and measuring the film-densities attained after processing. If the resulting densities are plotted against $\log_{10}$ (exposure), a graph is obtained which is known as a characteristic curve; the curve is, of course, only characteristic of the particular processing technique employed (see Fig. 1). The slope of this curve at any point is usually called the film contrast or, more precisely, the film gradient, and is denoted by γ_D.

* A Report by the Non-destructive Testing Sub-committee of the Steel Castings Division of the British Iron and Steel Research Association.

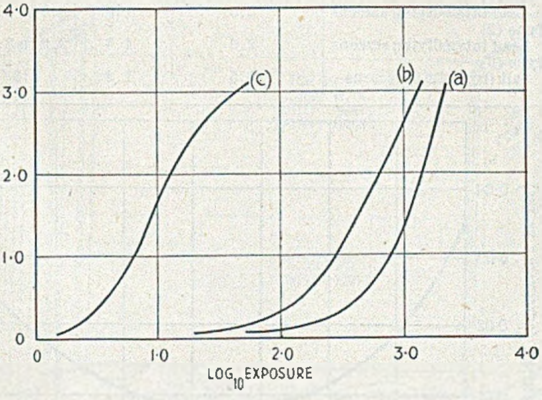

FIG. 1.—*Film Densities plotted against Exposure for (a) Fine-grain High-contrast Film with Lead Screens; (b) Ordinary Non-screen Film with Lead Screens; (c) Screen-type Film with High-definition Salt Screens.*

Other conditions being constant, the density difference in a radiograph between the image of a small flaw and that of the surrounding material is directly proportional to the film gradient. It is important, therefore, to determine the relation between density and film gradient, and typical results for various types of film are shown in Fig. 2. When a density difference on a radiograph is examined by holding the film against some form of illuminator, it is the difference in light-intensity reaching the eye through the two densities which is perceived. The sensitivity of the eye to small changes in brightness varies with the intensity of the incident light. The curves of Fig. 3 show the sensitivity of the eye to small changes of brightness and show that the eye is most sensitive to illuminations of 10 to 100 candles per sq. ft., although a density-difference of as little as 0.02 can be detected with an illumination intensity within the range of 0.1 to 20,000 candles per sq. ft.

Commercial X-ray film illuminators are usually reputed to have a brightness of 100 candles per sq. ft., so that density-differences of 0.02 can be detected in films up to a maximum density of 3.0, although the density range for maximum eye sensitivity with such illuminators would only be 0 to 1.0. It is probably safer in practice to limit the use of an ordinary illuminator to the viewing of films having a maximum density of 2.5, in order to allow for dusty interiors, old bulbs, or inefficient design. It is emphasised that routine precautions should be taken to keep illuminators clean and in efficient condition. If brighter illumination is available, for example, by means of "Photoflood" lamps, the density which can be viewed may be extended to 3.5.

Types of Radiographic Film

The films available for radiography may be classified according to their properties into three main types:—

(1) Fine grain, high contrast.—These films are generally used with metal intensifying screens and have the highest flaw-sensitivity of the three types.

(2) Ordinary non-screen.—These are for use with metal intensifying screens or without screens.

(3) Screen type.—These are for use with salt (calcium tungstate) screens. The flaw-sensitivity obtainable with the two latter types is very similar except when high-voltage X-rays and gamma-rays are used, in which case type (2) films are superior. A few types of ordinary photographic film are sometimes used when high resolution is required, but consideration of these is beyond the scope of these recommendations.

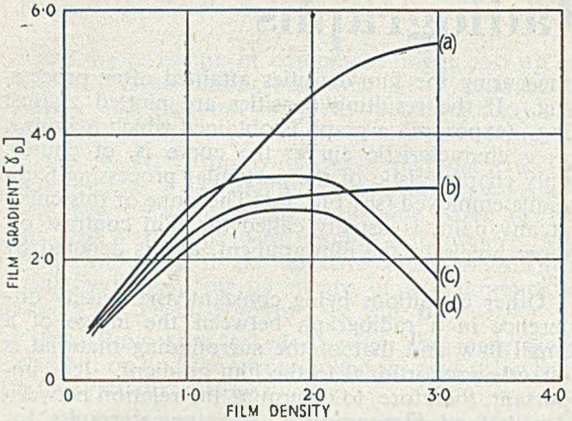

FIG. 2.—*Film Gradient Plotted against Film Density for (a) Fine-grain High-contrast Film with Lead Screens; (b) Ordinary Non-screen Film with Lead Screens; (c) Screen-type Film with High-Definition Salt Screens; (d) Screen-type Film with Lead Screens.*

In industrial radiography, the following film/screen combinations are used:—(*a*) Type (1) film with lead intensifying screens; (*b*) type (2) film with lead intensifying screens; (*c*) type (3) film with salt (calcium tungstate) intensifying screens; (*d*) type (3) film with lead intensifying screens.

Differences in the three types of film are shown in Fig. 2, in which the gamma/density curves corresponding to the above film/screen combinations are lettered respectively (*a*), (*b*), (*c*) and (*d*).

From the curves of Fig. 1, it will be noticed that type (1) films have the slowest speed, but at the same time exhibit the most steeply rising characteristic and, therefore, the highest contrast gradient. Furthermore, the curves of Fig. 2 show that the contrast gradient of type (1) films is at least 4.5, and of type (2) films 3.0 at a density of 2.0. Beyond the shoulders of these curves, the contrast continues to increase with increase of density above the normal viewing range, but more slowly for type (2) than for type (1). The contrast of type (3) films rises to a maximum which remains constant over a limited density range and then falls sharply with further increase of density. This property determines the maximum density to which films of this type should be exposed.

Recommended Density Values

The film densities recommended for the radiographic examination of ferrous castings differ according to whether the wall thickness of the portion examined in each radiograph is sensibly uniform or whether it varies. In the first case, the density of the radiograph is uniform and the best or optimum value of this *uniform* density has to be considered In the second instance the density varies over the radiograph, and it is necessary to know the *highest* and *lowest* permissible density values.

The optimum density can be defined as the minimum density needed to attain the required flaw-sensitivity, but in radiography it is seldom possible to evaluate the minimum permissible flaw-sensitivity and in practice the limit is usually fixed by the necessity of keeping the exposure time within reasonable limits. With films of types (1) and (2) the film gradient, and therefore the flaw-sensitivity, continue to increase slowly with film density beyond the density with which any illuminator available to-day will be adequate, this applying particularly to films of type (1). The optimum density then has to be a compromise between the high film-gradient attainable with very high film-densities, and the difficulties of providing adequate viewing conditions for densities above 2.5. Since it would be impracticable to list optimum densities for every known make of film, the values recommended are averages for each of the three types.

The useful density range is fixed by the maximum and minimum permissible densities. The minimum density is very important because it corresponds to the thicker portion of the casting; consequently the density must not be so low that there is any substantial loss of radiographic sensitivity. As the density decreases from its optimum value, the loss of detail is at first very small, but a point is reached beyond which the loss of detail becomes appreciable, and this point can best be determined by the examination of comparative radiographs of typical casting defects. The maximum density for type (1) and type (2) films should be the highest which can be viewed; the higher the density, the greater is the range of specimen thickness which can be examined in a single radiograph. The limits imposed by film illuminators have already been discussed. For type (3) films the maximum density is the point beyond which the contrast begins to fall rapidly.

The recommended values are set out in Table I, these being gross densities as measured. It is assumed that the fog is the normal value for each make of film when developed for 5 min. at 68 deg. F.

Subject range.—The useful range of film density is

TABLE I.—*Recommended Density Values.*

Film/screen combination.	Optimum density for specimens of uniform thickness.	Useful density range.	
		Minimum.	Maximum
Type (1) Lead intensifying screens	2.5	1.0	3.0 to 3.5
Type (2) Lead intensifying screens	2.0	1.3	3.0 to 3.5
Type (3) Salt (tungstate) screens	1.5	1.3	2.3

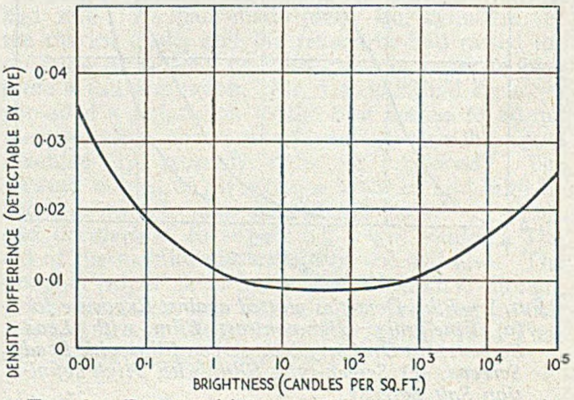

FIG. 3.—*Eye Sensitivity to Changes in Brightness.*

Density of Radiographs

only of significance in so far as it is related to the range of thickness in the specimen radiographed. A large density range does not necessarily imply a large corresponding range of specimen thickness. Thus the thickness ranges for type (1) and type (2) films are practically the same, the chief advantage of the type (1) film being the higher contrast and better resolution of fine detail, which greatly facilitates accurate interpretation.

(*Continued from page* 68.)

Discussion—Loam and Dry-sand Moulding

He was glad that the branch members had taken up the welding question. It showed that they were interested in the subject, and, after all was said and done, the foundry industry was the means of them

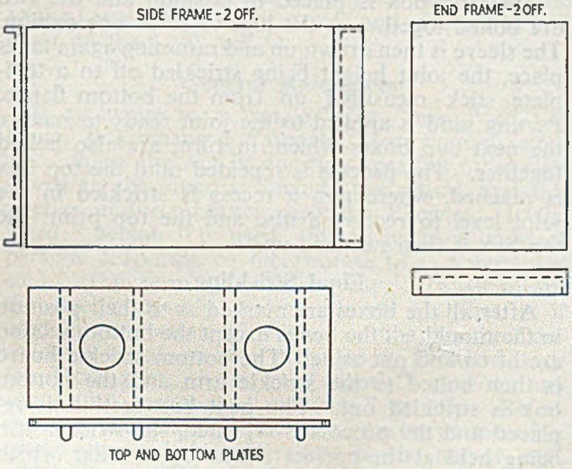

FIG. A.—*Sketch showing Frame for Core Assembly No. 1*

earning their bread and butter and the sooner they gave the customer what he really wanted the better. The amount of welding now being undertaken was a very disturbing factor.

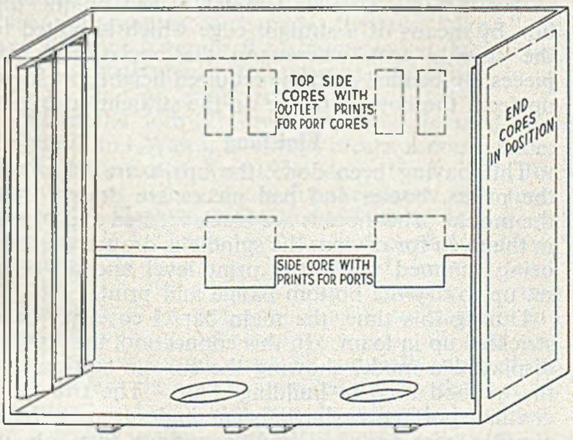

FIG. B.—*Frame for Core Assembly erected, showing the method of Core Placing. After the Bottom Cores are placed, the Side Cores are set, and both End Cores put in position. From that stage the remainder of the Cores are assembled.*

Combined Venting and Reinforcement

By "Tramp"

Due to the low specific gravity of aluminium alloys, difficulty is sometimes experienced in ensuring that the mould and core gases are speedily evacuated on pouring, and thus wasters are caused because of entrapped gas. To ensure the rapid removal of gas from a core it is essential that the vent be of as large a cross-sectional area as possible. Occasionally, when cores are almost completely surrounded with metal, and the only outlets are small holes which have subsequently to be plugged, difficulty is experienced to make the core

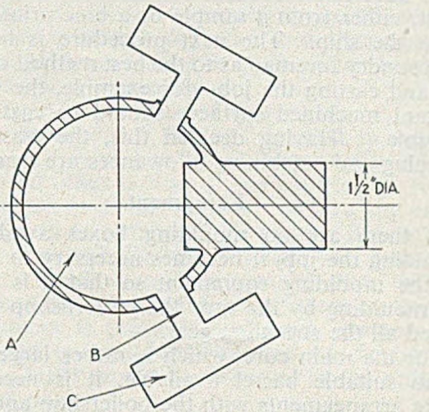

FIG. 1.—*Restriction of Venting Area by Solid Reinforcement Bar.*

sufficiently strong at the small part to carry the weight of the large portion of the core and also to allow of ample space for easy venting.

Such a case is shown in Fig. 1, where the heavy portion A must be carried by the two small portions B, C. The part acts as a balance to ensure that the core remains rigid in the mould during casting. To make certain that the balance prints carry the weight of the core, it is necessary to reinforce the portion B by means of a metal bar, entering into the main core and also the print portion. This so reduces the area available for venting that trouble occurs on casting.

A method whereby the necessary rigidity can be obtained without sacrificing the venting properties is to substitute a small perforated metal tube in place of the solid bar. By this means the gases are conducted quickly through the tube and the core posseses the required strength. The method is applicable to numerous jobs where restricted vents are to be found.

THE SWEDISH Iron Works Investigation Committee has stated that present plans provide for the investment of 391 million Swedish kronor to expand and modernise the Swedish iron and steel industry over the next two years. It is estimated that the industry will require an additional 2,900 workers by the end of this year.

Strickling a Five-ton Cylinder Liner*

By S. Wade

ALL THOSE employed in marine engineering will understand that, as a rule, a job of the nature of a 5-ton cylinder liner is usually a breakdown one and necessitates a replacement casting in a minimum of time. The time factor being of major importance, the Author has dealt with the job as a strickle job instead of a complete pattern and core box. To make a complete pattern and core box would take far too long as compared with strickling.

The first operation after being notified of the job is to have it set out full size in the pattern department, either from a sample or a blue print supplied from the ship. The next procedure is to consult the foundry foreman as to the best method of moulding and casting the job—for example, the most important machined surfaces should be cast down if possible. Having decided this, the waste metal, gripping and machining allowances are made.

Equipment

If there are no moulding boxes available for moulding the job, it becomes necessary to start first on the moulding equipment so that it is all ready for moulding by the time the patternshop has completed all the strickling gear.

For the main core, which is rather large, if there is no suitable barrel available, it is necessary to make arrangements with the boilershop and to have a plate marked off, vent holes punched and the plate rolled to the required diameter and welded along the joint. A pattern is made for the barrel core ends, which are cast in iron and fitted. It is also necessary to have another piece of plate rolled in the form of a sleeve and welded at the joint with two handles welded in the inside. The use of this sleeve in moulding will be explained later. When the barrel, the sleeve, the half-circular core-box forming the shape of the inlet and outlet ports in the liner, and the strickling gear have been completed, the job passes from the patternshop to the foundry.

Moulding

The moulding boxes by this time have been assembled with box bars to suit the outside diameter of the casting. The most satisfactory method of casting a liner is on end, and this being the case, a hole is dug in a selected part of the foundry large enough to accommodate the whole job except the top box with the clamping-down rails, runner box, riser cups, etc.

The spindle and foot are then set up, the foot being firmly rammed in position. It is most important that the spindle should be set with a spirit level in a perpendicular position. The coke bed is then rammed up, with the vent pipes set in position outside the moulding boxes. The bottom clamping rails are then rammed in position, provision being made to accommodate the holding-down bolts; this surface is then strickled off flush on the top of the rails, which also act as a base to receive the first moulding box.

The bottom print and flange, being in pattern form, are then bedded in with the runner ingate, which is drawn in later, and the surface is re-strickled. The bottom box is set centrally around the spindle, and stacked in position—the steel sleeve is then placed in position, and the moulding sand is rammed between it and the moulding box, around all the box bars. Provision is made for the pouring hole, this being a piece of steel pipe of the required diameter, drawn up through the ramming process.

The next box is placed in position and the two are bolted together at the lugs to form one section. The sleeve is then drawn up and ramming again takes place, the joint height being strickled off to a template stick measured up from the bottom flange. Parting sand is applied to the joint ready to receive the next two boxes which, in turn, are also bolted together. The process is repeated until the top box is reached, whereupon a recess is strickled in the joint level to receive a disc and the top print; the top box is then rammed up.

Final Strickling

After all the boxes are marked as to their position in the mould, all the boxes except the bottom section are lifted and put aside. The bottom strickle board is then bolted to the strickle arm and the bottom box is strickled out. The next box section is replaced and the process is repeated, the strickle arm being held at the correct height by a collar which is clamped to the spindle by means of a screw. Throughout the strickling operation, the spindle is given an occasional turn or two to prevent it seizing in its seat in spite of the fact that it is tapered.

The strickling having been completed, the next thing to do is to transfer the centre line from box to box from a circular templet placed on the top box by means of a straight edge which is bolted to the strickle arm, whereupon the bosses and pad pieces are bedded in at the required height measured up from the bottom flange on the straight edge.

Finishing

This having been done, the boxes are lifted off, the prints, bosses and pad pieces are drawn from the mould. The moulds are black washed and placed in the oven for drying; the spindle is drawn, the hole being rammed up to the print level and an open set up to dry the bottom flange and print.

During this time, the main barrel core has been strickled up in loam. In this connection, the Author displayed a model showing the core in section and the method used in building it up. The two half-circular port cores have been made from a half-circular core-box designed to receive two lots of inserts on account of the inlet parts being different in size and shape from the exhaust ports.

(*Continued on page* 73.)

* Paper presented to the Cape Town section of the South African branch of the Institute of British Foundrymen.

Legislative Statutes

By F. J. Tebbutt

MOST PERSONS and firms are nowadays in contact with Acts, Rules, and Orders, and therefore doubtless cogitation often occurs concerning whether an enactment applies to all or some, or to male or female—in fact, what the measure really embraces. There is a statute, however, the Interpretation Act, 1889, which answers most of these questions, and so we give a short explanation of this important measure, which simplifies the construction of Acts, and allows certain matters to apply to any Act—by virtue of this 1889 Act—even with no specific reference in the particular Act under review. Of course if there is specific mention in any enactment, that reference applies and not the general interpretation of words and phrases as laid down in the 1889 Act.

General References

If reference to a "male" (or "man," etc.) is made, this means a "female" (or woman, etc.), also, unless the Act in question specifies otherwise; words in the singular include the plural, and this applies in the contrary direction likewise. If the word "person" is used, this includes a body of persons corporate or incorporate (*e.g.*, companies, etc.). The term "financial year" always means the twelve months ending March 31; that is if used in connection with taxes or finance, the Consolidated Fund, moneys provided by Parliament, or the Exchequer; the term "month" used in any connection means a "calendar" month. Reference to the mayor, aldermen, or burgesses of a town, also includes references to the mayor, etc., and citizens of a city; and the word "county" covers the county of a "city" or a "town." Often in statutes the term "land" is used, and conjecture frequently arises as to whether this covers premises; the term "land" in statutes covers messuages, tenements, hereditaments, houses and buildings of any tenure, thus both residential and business premises come under the term "land." If any distance is required to be measured (laid down in any enactment), this means measured in a straight line on a horizontal plane.

When the term "County Court" is used, for England and Wales, it always means a court under the County Court Act, 1934, etc. (*i.e.*, courts for recovery of debts, etc.); for Scotland, the term "sheriff" includes "sheriff substitute," the term "sheriff clerk" includes "steward clerk," and any stewartry in Scotland is included in the term "shire" or "sheriffdom" or "county." Any "section" of an Act applies as a substantive enactment, without introductory words; all Acts are "Public Acts" and must be judicially noticed as such, unless otherwise provided for in the Act in question, and any Act can be altered, amended, or repealed in the same Parliamentary Session.

Commencement of Acts

Any expression used in an Order in Council, Order, Warrant, Scheme, Letters Patent, Rule, Regulation or Byelaw, Statutory Instrument, has the same meaning as in the Act in connection with which the instrument is issued; if an Act does not operate on the date of its passing, nevertheless any of the instruments just mentioned can be made before the commencing date of the Act, but will have no legal effect until the Act is actually in operation, and this also applies as regards the giving of notices, prescribing forms and so forth. Where an actual date of commencement appears in an Act (or in any of the instruments just mentioned) the Act is law immediately on the expiration of the previous day; the term "commencement" used in an Act means the time when the Act comes into operation.

Authorisation of Documents

If the expression "writing" is used in any enactment, this covers printing, lithography, photography, and other modes of representing or reproducing words in a visible form. Where any enactment requires or authorises the serving (this applies whether "serve," "give," "send" or other expression is used) of a document by post, the service is considered effected, if a letter containing the document is properly addressed, prepaid, and posted, and is considered effected at the time at which the letter would be delivered in the ordinary course of post.

It might be useful to note also that by the Wales and Berwick Act, 1745, even though only the term "England" appears in a statute, this term includes "Wales" without actual mention; for Scotland and Northern Ireland specific mention is made.

Strickling a Five-ton Cylinder Liner

(*Continued from page 72.*)

Closing

Everything being ready for closing the mould prior to casting, the main barrel core is lifted and placed in the bottom print, where it is rammed and set in a perpendicular position, the print joint being thoroughly dried with a large blow lamp.

The bottom box section is placed in position and the two half-circular cores are then rammed in position on the centre lines, the joint being thoroughly dried. The upper or mid-section is then placed in position and finally the top box, which closes the mould, is lowered over the barrel core which protrudes a few inches above the top box.

The rails are now put in position on the top box and clamped down with the bolts which are secured to the rails at the bottom of the mould, thus preventing any chance of the box joints opening under the pressure of the molten metal. The space around the outside of the moulding box and the floor itself is filled in and rammed up. The runner box with plugs and riser cups is set up on the top box, which completes the process of moulding, the mould being then ready to receive the molten metal.

Core Blowing in a Mechanised Foundry*

By S. Lane

TO MEET THE demands of an ever-increasing number of mechanised foundries and the high rate of mould production which is now an established fact, the core-blowing machine has been developed in almost every class of work. If used to capacity, along with good equipment, it is possible to produce cores at in-credible speed, which are in every way far superior to hand-made cores. The time taken to "blow" a box is only a matter of seconds, irrespective of the number of core impressions in the box. Therefore, to obtain the maximum production from the machine, it will be necessary, with a sufficient number of core boxes, to set up a cycle of operations around the machine which will consist of blowing, stripping, and assembling in a time comparable to that taken by the actual blowing operation. The blowing machines used in the plant are of the vertical type and are situated within a few feet of a continuous oven. This facilitates the stoving of the cores with little effort by the operators themselves.

The sand is prepared overhead and fed to the blowing machine by means of a hopper which is situated immediately over the blower head. The sand mixture must be strictly controlled if good results are to be assured, for so much depends on the flowability of the sand; excessive green strength will only result in stoppages due to the build-up of sand inside the blower head.

Core Boxes

Both vertically- and horizontally-jointed boxes are on the machines, the vertically-jointed boxes being blown through the apertures at the top of the box. If the core is one of larger diameter it can be blown through several holes in the blow plate. A supplementary plate is secured under the blower plate into which the air outlet vents are fitted, thus allowing the air from the top of the box to escape through narrow grooves between the two plates. This will eliminate the use of the top blower-plate which only adds bulk and weight to the core boxes. The horizontally-jointed boxes are blown through small steel tubes which are built into the structure of the box on to the profile of the core itself. The number of tubes required can only be determined by the shape of the core to be blown and the volume of sand required in the core. The boxes are of aluminium construction, and are reinforced with replaceable $\frac{1}{8}$-in. thick steel inserts and facing at all points which are subject to hard wear, *i.e.*, the base of the boxes which get so much abrasion due to the sliding under the blower head, and the points which come in contact with the stops. Vertically-jointed boxes are adequately ribbed to give a good clamping surface and so prevent any straining of the boxes whilst under pressure. The horizontal types are supported with sturdier ribs which are so placed to give a perfect seal to the boxes and to prevent any distortion during the blowing operation.

Provision of Breathers

The location of the breathers in the core boxes is also governed by the shape of the cores and the position of the blowing tubes. Sufficient breathers to influence the flow of sand inside the box are placed at points furthest away from the tubes, and adjacent to any ribs or pockets which there may be in the make-up of the core box. Insufficient breathers or any resistance to the free flow of air through the box will tend to create pockets of air inside the blower head, which will prevent the boxes filling with sand when blown.

Since the blown core is of higher permeability than that made by hand, many of the cores produced on the blower will not require any form of venting. For the larger cores, several methods of venting are used. With the vertically-blown boxes, a vent plate is used which is made up of steel tapered pins secured to a thin metal plate. This is placed under the corebox before it is blown and removed before the box is taken apart.

With the horizontally-jointed boxes, two methods are used:— (1) a vent rod is passed through a metal bush which is let into the structure at one end of the box, and is secured into a recess at the opposite end. The rod is withdrawn immediately after blowing the core, while the box is still under the machine, and (2) tapered wires are placed into small grooves on the joint face before the box is assembled ready for blowing, and are withdrawn after the cores are turned out into the cradles. Where reinforcing irons are used in the cores, they are supported in the box by small round pillars which are set up in the bottom half of the box. Any wires which may be used must be offset to the blowing tubes, thus avoiding any obstruction to the flow of the sand entering the box.

The blowing head should not be too large in comparison with the cores to be blown, for, with too large a head it will be necessary to install a metal insert inside the head to reduce the area of the blowing plate, and to give a lead to the flow of sand towards this blowing hole. The sizes of the blowing holes in the plates are strictly determined by those in the core boxes, and should not be any larger, as this will tend to impede the flow of sand into the box, and so cause tunnelling in the blower head. To ensure the true location of the boxes under the blower head so that the holes in the plate line up with those in the boxes, stops are fitted in position underneath the blowing plate.

Design Requirements

In the designing of core boxes for the blower machine, much consideration should be given to standardisation wherever possible, *i.e.*, height of the horizontally-jointed boxes and width of the vertical ones. This will save much time in machine adjustments when changing from one job to another. Also, a series of boxes containing different core impressions, can be included in the cycle of boxes used at any one time on the machine. The joints of the boxes should be stepped or baffled to create a perfect seal and prevent any sand penetrating the joints, thus adding life to the box. The loose pieces must be a perfect fit and be so designed as to resist any sand infiltration into the cavity around them which may cause them to stick. Considering the rate at which the operators will be expected to handle the boxes, the aim must be to design a core box which will be easy to handle, and not too heavy, thus eliminating any excessive fatigue of the operators which would result in loss of production. The blowing tubes should be set $\frac{1}{64}$ in. proud above the top of the boxes to ensure a perfect seal to the blower head.

For successful core-blowing production, checking of the following points is essential:—

(1) Cleanliness of breathers and boxes; (2) immediate replacement of damaged breathers; (3) constant air pressure; (4) side clamps to be maintained at a high level of efficiency; (5) regular check of loose pieces and replacement when worn; and (6) replacements of metal facings at points which may throw the blowing holes out of true.

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* An entry from a prize competition organised by the Lincoln branch of the Institute of British Foundrymen.

News in Brief

AT A COST OF £9,000, Stewarts and Lloyds, Limited, are to erect a new canteen and a new drawing office at Phœnix Works, Rutherglen, Glasgow.

THE BOARD OF TRADE has announced that there will in future be no restrictions on the use of paper for advertising circulars and trade catalogues.

WOODEN PATTERNS to the value of about £500 were destroyed recently by fire at a stores of the Brightside Foundry & Engineering Company, Limited, Ecclesfield, Sheffield.

JOHN WIGHAM & SONS, LIMITED, ironfounders and shiprepairers, of Sunderland, are being wound up voluntarily. Mr. R. Lofthouse, 18, John Street, Sunderland, is the liquidator.

PRESENTATIONS HAVE BEEN MADE to over 100 employees of Thos. Summerson & Sons, Limited, and Summerson's Foundries, Limited, Darlington, with 25 years' or more service.

ENTERTAINED AT A SOCIAL last Monday by the directors of Thos. W. Ward, Limited, Sheffield, were over 300 members of the Permanent Way Institution, which is holding its convention in the city.

THE REPUBLIC OF IRELAND imported iron and steel and manufactures (excluding cutlery and machinery) to a total value of £684,672 in May, against £588,564 in the corresponding month of 1949.

A SEVEN-DAY STRIKE of some 500 foundrymen employed by David Brown-Jackson, Limited, Salford (Lancs), ended on July 10, when the employers agreed to confer with union officials on the retiming of certain jobs.

A SITE in Birmingham Road, West Bromwich (Staffs), has been acquired by W. & T. Avery, Limited, weighing-machine manufacturers, of Birmingham, for the purpose of the erection of a showroom, an office, and a repair workshop.

WITH A TOTAL of 6,240 years' service between them, 348 employees of John Thompson, Limited, Ettingshall, Wolverhampton, have received presentations. Since 1924 a total of 97,000 years' service has been recognised in this manner.

TEES IMPORTS of Continental iron and steel scrap during the second quarter of 1950 totalled 74,000 tons and in the first quarter 80,000 tons, an aggregate of 154,000 tons for the half-year. This is believed to be a record for any half-yearly period.

THE SOCIETY OF INVENTORS' annual exhibition, "Prototypes into Products," will be held at the Typographical Institute, Bath Street, Birmingham, from September 2 to 9. Full details may be obtained from Mr. B. T. Clark, 244, Stoney Lane, Yardley, Birmingham.

KIRKSTALL FORGE ENGINEERING, LIMITED, acquired just over a year ago the whole of the share capital of Kirkstall Forge, Limited. In order to simplify the administration, Kirkstall Forge, Limited, were liquidated on June 30, and the whole of their assets and undertaking have been transferred to Kirkstall Forge Engineering, Limited, which became the operating company as from July 1.

THE B.E.A. has received the consent of the Minister of Fuel and Power to develop four new power stations to their full capacity. Three of the stations will each have a total installed capacity of 180,000 kW. when completed. They are at East Yelland, near Barnstaple (Devon); Connah's Quay, in Flint; and Acton Lane, Willesden, London. The fourth station, at Brighton, when completed, will have a total installed capacity of 330,000 kW.

IN ACCORDANCE WITH a statement made by the Chancellor of the Exchequer in the House of Common last Tuesday, the Board of Trade announces that existing open general licences issued in connection with the policy for the liberalisation of trade have been extended to Belgium, Luxemburg, and the Belgian Congo, with effect from July 17. This will result in a large range of goods from these countries being freed from import licensing restrictions.

THE NUFFIELD FOUNDATION, established by Lord Nuffield 10 years ago, has made a grant of £25,000 to the New South Wales University of Technology to endow a Nuffield Research Chair of Mechanical Engineering. This is the first of the grants which the Foundation intends to make for research at Dominion universities and similar institutions in the British Commonwealth. Travelling fellowships are being offered to the new Dominions of India, Pakistan, and Ceylon.

ACCORDING TO the Economic Co-operation Administration mission in London, the United Kingdom received authorisations for $9,500,000 worth of crude oil and petroleum products and $10,500,000 worth of copper and aluminium during May. Total Marshall-aid authorisations for Britain during the month were $24,200,000—the second largest sum earmarked in May for any country in the European Recovery Programme.

THE LOW WALKER SHIPYARD of Sir W. G. Armstrong, Whitworth & Company, Limited, Gateshead, is being offered for sale for development for a new industry. The yard was closed some years before the war by National Shipbuilders' Security, Limited, but, unlike other yards taken over, was not scrapped. In 1940 it was reopened by the Tyne branch of Shipbuilding Corporation, Limited, and between then and 1947, when it launched its last ship, 36 vessels were built.

West German Iron and Steel Output

From 724,763 metric tons produced in May, pig-iron output in Western Germany rose to 761,352 tons during June. The output of steel ingots and castings increased from 936,931 tons to 1,004,770 tons. The provisional output figure for steel ingots and castings during the first half of this year is 5,670,000 metric tons.

Satisfaction is expressed by West German industrialists at the recent lifting of the steel embargo for deliveries to the Eastern part of Germany and the consent of the Allies for Western Germany to revive her trade with the countries of South-Eastern Europe. It is believed that the steel embargo never was really effective and that, for instance, West German steel delivered to Holland eventually found its way to Eastern Germany, who became a favourite customer to other countries while the West German steel embargo lasted.

On this occasion, the total iron and steel requirements of Eastern Germany in 1950 are stated to be from 1,200,000 to 1,300,000 metric tons. Of this total, it appears that Western Germany will supply 200,000 tons (including some 150,000 tons already delivered); 300,000 tons will be produced within Eastern Germany; between 600,000 and 700,000 tons will come from Russia, and some 100,000 tons from other countries, such as Poland, Austria, Czechoslovakia, Holland (re-exporting West German material), and Britain (probably *via* Sweden).

It is also stated that the embargo has caused heavy losses to the West German iron and steel industry, partly because of the foreign competition decribed above and partly because the initial stages of production to Eastern Germany's specifications had been completed, thus making the finished products unsaleable elsewhere.

Book Reviews

The Properties of Metallic Materials at Low Temperatures. By P. Litherland Teed. Published by Chapman & Hall, Limited, 37, Essex Street, Strand, London, W.C.2. Price 21s. net.

The principal emphasis of this study is on mechanical properties of metals and alloys at low temperatures; it will be valued primarily, therefore, by structural and mechanical engineers, but metallurgists will find it of considerable interest. The Author summarises and unifies the extensive but scattered information on the subject, digesting results reported by previous investigators and presenting them in convenient tabulated form. Two preliminary chapters outlining general principles introduce a comprehensive treatment of the behaviour at sub-atmospheric temperatures of steels, magnesium alloys, aluminium, copper, nickel, zinc, tin, lead and their alloys. The Author also discusses the crystal structure of metals and alloys in relation to their properties at low temperature. Impact strength of steels and the mechanism and value of notched-bar tests receive detailed attention, and the occurrence of notch brittleness at low temperatures is explained. The need for experiment in cases where positive evidence is lacking is urged throughout the work. Foundrymen will be disappointed that cast iron receives no mention in this volume. The limited, but nevertheless important, information available on the low-temperature properties of this material appears to have been completely overlooked.

Engineers and designers will find this a useful reference work. The information it contains could be obtained previously only by an arduous search of the literature. The interpretation of the results is excellent, and the layout commendable. The text is illustrated by 45 tables; extensive bibliographies are given at the end of each chapter.

G. N. J. G.

Conference on Foundry Steel Melting. Published by the British Iron and Steel Research Association, 11, Park Lane, London, W.1. Price 10s.

The FOUNDRY TRADE JOURNAL printed a summary of the outstanding features of this conference immediately after its conclusion, but to receive the full benefit, recourse to this brochure must be made. The outstanding merit of the book is the information disclosed as to the use of oxygen in steel melting. Mr. Martin's little "sermon" on productivity was in the best "Martinesque" style, which means "pep," pungency and philosophy. Other Papers which appealed to us were Mr. A. C. Brearley's review of foreign practice and Mr. F. N. Lloyd's short Paper on costing the melting process. The latter settled the point from the cost aspect, but the furnace must be still subservient to the moulding floor.

Definitions and Formulæ for Students—Metallurgy (4th edition). By E. R. Taylor. Published by Sir Isaac Pitman & Sons, Limited, Parker Street, Kingsway, London, W.C.2. Price 1s.

This little book is very good value for money, the only difficulty is the sending of a shilling by post unless one includes the purchase of a postal order when procuring others for the pools. Of course, in a matter of 43 pages, it is not possible to make the list exhaustive, but the selection of definitions is quite good and the reviewer recommends the book to students.

CENTENARY CELEBRATIONS at South Shields will include an industrial exhibition covering 20,000 sq. ft.

Board Changes

VERITY'S, LIMITED—Mr. C. K. Pitt has resigned from the board.

BRITISH OXYGEN COMPANY, LIMITED—Mr. E. Carnegie has retired from the board.

GUEST, KEEN & NETTLEFOLDS, LIMITED—Lt.-Col. The Hon. C. H. C. Guest has resigned from the board.

JOHN BROWN & THOS. FIRTH (OVERSEAS), LIMITED—Sir Frank H. Nixon, who joined the board in 1946, has resigned as a director.

HENRY MEADOWS, LIMITED—Mr. H. O. Field, a former chief oil-engine designer for Tangyes, Limited, has been appointed a director and general manager.

JOHN BOLDING & SONS, LIMITED—Mr. Joseph Edmund Grove, a joint managing director, has been appointed chairman to succeed the late Mr. Albert Edward Crapnell. Mr. Grove has been a director and associated with the company for 16 years.

SWAN, HUNTER & WIGHAM RICHARDSON, LIMITED—Mr. P. L. Jones, manager of the Neptune Works, has been appointed a director. A director of the Wallsend Slipway & Engineering Company, Limited, Mr. Jones is a vice-president of the Institution of Mechanical Engineers and a member of council of the North-East Coast Institution of Engineers and Shipbuilders.

1951 Exhibition in Glasgow

Glasgow's contributions to the 1951 Festival of Britain will include an exhibition at Kelvin Hall telling the story of the development of power during the past 100 years and which will also be a tribute to British heavy engineering. Mr. Basil Spence, who was responsible for the Britain Can Make It and the Scottish Enterprise exhibitions, is the architect of the exhibition.

On entering the exhibition, the visitor will be confronted with two spectacular settings representing coal and water, the two main sources of power. From here, he will proceed through a series of sections, illustrating the development of iron and steel, steam, electricity, railways and shipbuilding, and hydro-electricity. The tour will culminate in the Hall of the Future, symbolising the development of the power of the future derived from the atom.

Recent Shipbuilding Orders

Among recent shipbuilding orders announced are the following:—

FERGUSON BROS. (PORT GLASGOW), LIMITED—Two tugs for the Clyde Shipping Company, Limited, Glasgow.

GOOLE SHIPBUILDING & REPAIRING COMPANY, LIMITED—It is understood that a contract for a cargo motorship of 1,200 tons dw. has been taken over by Coast Lines, Limited.

FURNESS SHIPBUILDING COMPANY, LIMITED, Haverton Hill-on-Tees, Billingham (Co. Durham)—A motor tanker of 24,850 tons for London & Overseas Freighters, Limited. Six similar vessels are either on order or being built for other owners.

Belgian Foundry Association

At the annual general meeting of the *Association Technique de Fonderie de Belgique*, Mr. Commings, the retiring honorary secretary, was presented with an inscribed pewter pot cast from an eighteenth-century mould forming an exhibit in the Walloon Historical Museum at Liège. The retiring president, Mr. René Deprez, was also the recipient of a presentation. It took the form of a bell, cast in the well-known foundry of Marcel Michiels of Tournai. The meeting was followed by a luncheon party at the Hotel Wiser, Liège.

Iron and Steel Institute

The Council of the Iron and Steel Institute have accepted an invitation from the West of Scotland Iron and Steel Institute to hold a special meeting in Glasgow from Tuesday to Friday, September 12 to 15, 1950. The Lord Provost of Glasgow has kindly agreed to be patron. Reception, executive and ladies' committees have been formed the chairmen being Sir Andrew McCance, Mr. W. Barr (president of the West of Scotland Iron and Steel Institute) and Lady McCance. Mr. P. W. Thomas, secretary of the West of Scotland Iron and Steel Institute, has consented to be honorary secretary; Mr. R. A. Hillis, of Colvilles, Limited, is helping with the arrangements in Glasgow.

The first morning will be devoted to a technical session, which will be held jointly with the West of Scotland Iron and Steel Institute. In the afternoon one of the following works may be visited:—Stewarts and Lloyds, Limited, Clydesdale Works, Mossend; Clyde Alloy Steel Company, Limited, Motherwell; G. & J. Weir, Limited, Cathcart; Albion Motors, Limited, Scotstoun. On Wednesday, following a joint technical session, one of the following visits may be undertaken, with lunch at the works:—W. Beardmore & Company, Limited, Parkhead; Lanarkshire Steel Company, Limited, Motherwell; Babcock & Wilcox, Limited, Renfrew; R. B. Tennent, Limited, and Lamberton & Company, Limited, Coatbridge. On Thursday morning, September 14, one of the following works may be visited:—Colvilles, Limited, Clyde Iron Works, Cambuslang; Colvilles, Limited, Clydebridge Steel Works, Cambuslang; Harland & Wolff, Limited, Scotstoun; Duncan Stewart & Company, Limited, Bridgeton. Alternatively, one of the first two works may be visited in the afternoon, or Colvilles, Limited, Glengarnock, or Anderson, Boyes & Company, Limited, Motherwell. An all-day excursion on the Clyde in s.s. Queen Mary II will include a visit to John Brown & Company, Limited, on the Friday.

U.K. Trade in June

The provisional value of United Kingdom exports was £175.9 million in June, a month of only 25 working days. Adjusted to a standard month of 26 working days, the figure would be £182.9 million, or slightly above the record May total of £182.6 million.

Imports were valued provisionally at £238.6 million and re-exports at £6.2 million, the excess of imports (valued c.i.f.) over exports and re-exports (valued f.o.b.) being £56.6 million, making the adverse visible balance for the first half of this year £220.5 million, compared was £199.1 million in the same period in 1949 and £230.4 million in July-December, 1949.

The value of imports in June was the highest on record. Last year imports rose to a peak in June and the pattern for this year has been very similar, although the rise in the last three months has been rather steeper than in the same period a year earlier.

Engineers Favour Arbitration

The result of the ballot on the engineers' claim for a £1 a week wage increase was announced at a meeting of the Executive Council of the Confederation of Engineering and Shipbuilding Unions at York last Thursday. It showed that 111,048 votes were cast in favour of strike action and 326,233 for arbitration.

New Catalogues

Electric Furnaces. Birlec, Limited, of Tyburn Road, Erdington, Birmingham, 24, have sent us two catalogues, both very well presented. One covers the subject of vertical forced-air-circulation furnaces so extensively used for the heat-treatment of light-alloy components and the second for larger batch-type heat-treatment furnaces, and into this category enters vitreous enamelling furnaces. It is not as generally well recognised as it should be, that the electric-furnace designer, because of his essentially neat productions has had a profound and beneficial impact on the design of industrial furnaces generally. Before the electric furnace the average metallurgical plant developed bulges, and had the shapelessness of a derelict country cottage. Happily the challenge has been taken up—and usually successfully—by all furnace designers. In these two catalogues, especially in the one dealing with batch-type furnaces, reliance has been placed on photography, with very worthwhile results. In the forced-air-circulation-furnace booklet a full technical description of the plant and process, together with a pyrometric chart of a charge progress recorder, has been included. With these two booklets, there was a third one, which issues an invitation to visit the works. It sets out the names of the chief personnel, and details by diagram and letterpress the services which are accorded to all visitors who are deemed by the hosts invariably to be V.I.P.S.

Foundry Plant. No fewer than thirteen pamphlets have been received from the Gibson Engineering (Sales) (Pty.), Limited, of 29 to 33, Wilson Street, Redfern, Australia. Seven deal with moulding machines, as would be expected, for the firm claims that 80 per cent. of those installed in Africa, Australia and New Zealand are of this make. A feature of the majority of the machines is the absence of foundations, which works out well in a mechanised foundry where an underground spill conveyor is envisaged. In the coreshop, there are a hand-operated jolt-roll-over machine; a "sausage" machine; a simple core-sand mixing machine and two types of very interesting core blowers. The simple one, known as the "Blowmatic," requires an air pressure of 60 to 80 lb. per sq. in., and incorporates but four moving parts. It is surmounted by a detachable sand container, uses a standard control valve, and only necessitates finger-tip operation. The second —the "Drawmatic"—also has but four moving parts, but, in addition, features an automatic draw. Finally, there is a catalogue covering vibrators. The leaflets and brochures have not been standardised as to either size or layout, but in general reach a high level and equal those emanating from the home manufacturers.

Nickel Aluminium Bronze Castings. The Mond Nickel Company, Limited, Sunderland House, Curzon Street, London, W.1, have just issued a most useful brochure on this alloy, which is covered by B.S. 1400, AB2-C. It is an alloy which gives a minimum tensile strength of 40 tons per sq. in. associated with a minimum elongation of 12 per cent. The brochure, which is well illustrated, carries a quantity of technical data as to mechanical properties under various conditions—including fatigue, corrosion and erosion resistance, those at high and low temperatures, as well as details regardng machinery, welding, brazing and soldering. The part which will be best appreciated by our readers is contained in the last four pages, which are full of good practical advice as to how to handle the alloy in the foundry. This brochure is of the usual high-grade standard to be associated with "Nickel" publicity.

Publications Received

T.I.'s Handbook for Supervisors. Published by Tube Investments, Limited, The Adelphi, London, W.C.2.

Since the war, a veritable library has come into being on the important subject of human relations. Most of the material is a repetition of what has previously been written, but each contribution has its own psychological twist. In the book under review, there is set out in tabular form, using a minimum of words, the duties of the chargehand, the foreman and the superviser. If these precepts be followed, there is no need for further diatribes on the subject. Everybody can instance additional attributes desirable in the mental make-up of a foreman. One for instance we could cite is that where amongst the employees there are "spivs," then the foreman must be still quicker "on the uptake" to command their respect—that is, if they can possess such a quality. However, the majority of works, except for wartime, are free from this type of individual. With a normal staff, however, such matters never arise.

It should be understood that this is a manual for the staff of the Tube Investments, Limited, and so there are included details of a works pension scheme and much matter of this description. Wisely, the book is of a loose-leaf type so that additional matter can be added from time to time. A useful feature is the inclusion of references to important Acts of Parliament affecting the work of supervisors. The reviewer compliments those responsible for this publication.

Guide to Industrial Film Making. Prepared by the British Electrical and Allied Manufacturers' Association and the British Engineers' Association, and published from 36, Kingsway, London, W.C.2, and 32, Victoria Street, London, S.W1. Price 2s.

Any concern envisaging the creation of an industrial film would be well advised to procure a copy of this brochure, as there are no fewer than 19 steps to take between start and finish. Moreover, there are a number of snags in the business such as the demands of the Performing Rights Society. Still if the job is worth doing, it is worth doing well, for a poor industrial film is no advertisement. Among the worthwhile features in the brochure is a glossary of the terms used. The estimates of costs make interesting reading as the cameraman gets more money than his director!

Wie werde Ich Giesserei-Ingenieur? (why should I be a foundryman?). Issued by the Rheinish-Westfälischen Technischen Hochschale, Aachen.

This booklet has been written by Professor Piwowarsky with the object of informing potential students of the opportunities for successful careers open to those who graduate at the school under his direction. Information is given as to the industry to be serviced, the nature and cost of the tuition given, and the social activities available.

Classified Handbook of Members and their Manufactures. 21st (1950) Edition. Issued by the British Engineers' Association, 32, Victoria Street, London, S.W.1.

This stoutly-bound, well-presented annual is in the main sent abroad to engineers' buyers. Regarded from this angle, it is a most useful book as, by advertisement and listing, engineering products are emphasised in a commendably attractive manner.

Further Steel Output Record

Two further steel production records are announced by the British Iron and Steel Federation Output in the first half of this year was 8,309,000 tons, which established an all-time record for any six-monthly period. It was 351,000 tons higher than the previous best half-year, which was the first half of 1949. The June output was the highest ever reached in that month. Production last month was at an annual rate of 16,249,000 tons, compared with the previous best—15,645,000 tons in June, 1949.

Pig-iron output last month was at an annual rate of 9,474,000 tons, this comparing with 9,664,000 tons a year ago.

The latest steel and pig-iron production figures (in tons) compare as follow with earlier returns:—

	Pig-iron.		Steel ingots and castings.	
	Weekly average.	Annual rate.	Weekly average.	Annual rate.
1950—May	185,500	9,646,000	319,200	16,597,000
June	182,200	9,474,000	312,500	16,249,000
1st half-year ..	184,800	9,611,000	319,600	16,619,000
1949—May	186,500	9,700,000	315,600	16,409,000
June	185,800	9,664,000	300,900	15,645,000
1st half-year ..	181,600	9,442,000	305,700	15,897,000

U.S. Non-ferrous Metal Industries

The productivity team from the U.K. non-ferrous metal industries, which is in the United States, has completed half the tour arranged by the Anglo-American Council on Productivity. Eleven factories had been visited by the end of June in the four States of New York, Pennsylvania, Ohio, and Michigan.

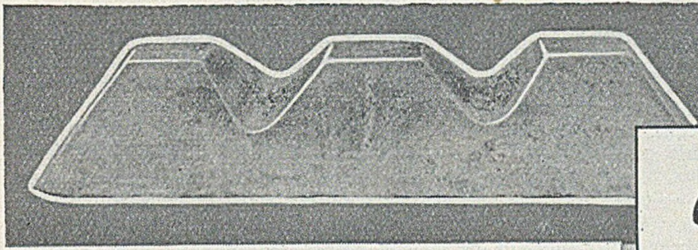
Among the first impressions reported to have been derived by the team from the American factories are the following:—The attention given to time and motion study with the acquiescence of the workpeople; the continuity of machine operation; excellent and attractive packaging of goods; the educational standard of the younger American workers; an easily comprehensible wage structure; concentration on standard lines; efficiency of the small factories; photography for work study; the American worker does not exert more physical effort than his British counterpart, but works more continuously and is assisted by better mechanisation.

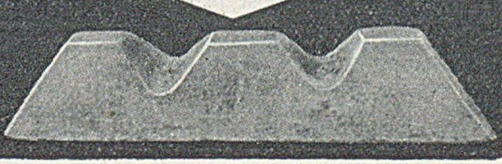
J. Stone and Company

It is proposed by J. Stone & Company, Limited, Deptford, London, S.E.14, to incorporate as wholly-owned subsidiary companies two new companies to be known as J. Stone & Company (Charlton), Limited, and J. Stone & Company (Deptford), Limited. The foundry and marine sections will be transferred to the Charlton company and the electrical engineering section will be transferred to the Deptford company.

The new companies will commence to operate from December 31, 1950, and the parent company will be come a holding company, the name of which is intended to be changed to J. Stone & Company (Holdings), Limited, with effect from December 31, 1950.

THE FORD MOTOR COMPANY, LIMITED, Dagenham (Essex), established a new production record last month with an output of 18,765 cars, commercial vehicles, and tractors, which brings the total for the half-year to 100,890 vehicles, compared with 151,793 produced during the whole of 1949. The company's £12,000,000 re-equipment programme is steadily progressing.





Company News

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

Butterley Company, Limited:—The company has received compensation in full in respect of its main line wagons, and a capital profit of £264,036 has accrued. It is proposed to distribute £252,000 of this to the shareholders, representing 14 per cent. on the ordinary stock, and it is advised that this payment will not attract either income tax or surtax.

The issue of £2,000,000 of Coal stock, referred to in the directors' report, was made on June 16. The stock has been realised, and the effect has been to turn a deficiency of current assets of approximately £300,000 into a balance of some £1,700,000. Further sums of cash and issues of stock on account of compensation will continue to be received. The board considers that the time has come for a modification of the capital structure of the company, and, therefore has under consideration a scheme to reduce the paid-up ordinary stock.

Mr. E. Fitzwalter Wright told the shareholders at the annual meeting that at the engineering works at Butterley and Codnor Park a still further increase in output had been obtained, and sales from these two works reached a record figure of just under £2,000,000.

Glacier Metal Company, Limited:—The directors announce that permission is being sought to erect buildings which will increase the floor space of the London factories by some 10 per cent., in order to provide more space in the production shops, better storage facilities for raw material and work in progress, and new premises for the research and engineering development staff. It is hoped that the additional space may be available before the end of the financial year (February 28, 1950). Since the last annual report, the order position at the company's Kilmarnock factory has improved very considerably, and the factory now employs just over 500 people. Negotiations are in progress with Scottish Industrial Estates to double the size of the factory. The extension when built will provide for the installation of certain continuous processes, some of which will be transferred from London.

Universal Grinding Wheel Company, Limited:—An extra-ordinary general meeting of the company will be held on July 27 to consider proposed new articles of association. The directors point out that they do not involve any material alterations in the rights of either class of stockholder but draw attention to the provision authorising the establishment of schemes for employees' shares and specifying restrictions to be attached to such shares, and the proposed reduction in a director's share qualification from £1,000 to £100.

Triplex Foundry, Limited:—New mechanised moulding plant is now almost ready to go into operation and, in addition to the manufacture of the castings required for the company's own production, the chairman, Mr. H. E. Hind, says that there is every prospect of receiving orders for other castings which should utilise it to full capacity. It is not anticipated that the full benefit will be felt in the current year, as there is still a considerable amount of patternmaking to be carried out.

Sanderson Bros. & Newbould, Limited:—The chairman, Mr. J. Harold Brown, says that 1949 was a year of increased sales, despite the continuation of various restrictions on trading in the form of controls, licences, quotas, etc. "I must add, however, that there are definite indications that the seller's market which has existed for so long in steel has virtually gone and an increasing amount of severe competition is being experienced, particularly in quality steels."

Allied Ironfounders, Limited:—Demand was well maintained in the year to March 31 last, and although the net profit was slightly less, the volume of turnover was higher than last year, says Mr. James Shaw, the chairman. This lower ratio of profit was mainly due to rising costs in wages and materials only partially covered by increased selling prices in certain sections.

George Turton, Platts & Company, Limited, drop forgers and stampers, of Wincobank, Sheffield:—Extraordinary and class meetings have been called for July 14 to consider the adoption of new articles. Among new provisions is a declaration that preference shareholders will have one vote per share on a poll, a matter on which the present articles are silent.

John Summers & Sons, Limited:—Underwriting arrangements are being made for a £5,000,000 debenture issue. The interest rate is 4 per cent. and the stock has been priced at 98. Subscription lists will open next Thursday. The stock will be redeemed at par on June 15, 1975, with the option to the company to repay at any time on not less than three months' notice.

Obituary

Mr. Richard Southerton, who joined W. & T. Avery, Limited, weighing-machine manufacturers, of Birmingham, when his father was a foreman there, has died at the age of 94.

Mr. N. Gunn, a director and secretary of Mullard Electronic Products, Limited, and of its associated companies, died suddenly on Friday last. He joined the Mullard Radio Valve Company as assistant to the managing director in 1924.

Mr. H. Oscroft, a member of the governing council of the National Association of Drop Forgers and Stampers, and manager of the drop-stamping department of George Turton, Platts & Company, Limited, Wincobank, Sheffield, died last week.

Mr. Edward J. Hardy, chairman of Birfield Industries, Limited, Witton, Birmingham, died on Monday at the age of 76. He was founder and deputy-chairman of Hardy, Spicer & Company, Limited, manufacturers of flexible and mechanical joint couplings, and chairman of the Phosphor Bronze Company, Limited. He was also on the board of Forgings & Presswork (Birmingham), Limited, and of the Laycock Engineering Company, Limited.

Wills

Harrison, R. C., founder of R. C. Harrison & Sons (Brassfounders), Limited, Leicester	£25,162
Bird, Frank, a director and secretary of the Audley Engineering Company, Limited, Newport (Salop)	£9,966
Wilkinson, William, formerly a director of Judson & Hudson, Limited, engineers and millwrights, of Keighley (Yorks)	£6,387
Dixon, H. R., a director of the North-Eastern Marine Engineering Company (1938), Limited, Wallsend-on-Tyne, and of Richardsons, Westgarth & Company, Limited	£39,444
Johnston, H. J. C., chairman of the Leeds Fireclay Company, Limited, Leeds, and a past-president of the National Federation of Clay Industries and the British Ceramic Society	£21,237
Roper, J. B., late a director of Brooker, Dore & Company, Limited, metal merchants and exporters, of Fenchurch Street, London, E.C.3, the Glyco Metal Company, Limited, Fairfield, Droylsden (Lancs), and Hurseal, Limited, heating engineers, of Regent Street, London, W.1 ...	£49,997

Company Results

(Figures for previous year in brackets.)

WHITEHEAD IRON & STEEL COMPANY—Final dividend of 17½%, making 30% (same).

HAMMOND LANE FOUNDRY COMPANY—Dividend of 2½%, making 15% for the 15 months ended March 31.

DARLINGTON & SIMPSON ROLLING MILLS—Net profit for the year to March 31, after all charges, including taxation, £74,369 (£92,446); to general reserve, £32,500 (£45,000); dividend of 9% (same); forward, £43,792 (£42 871).

W. G. ALLEN & SONS (TIPTON)—Net profit for the year to March 31, £21,075 (£21,818); final dividend of 7½%, making 10% (same); written off land and buildings, £365 (£1,666); general reserve, £9,000 (£11,000); taxation equalisation reserve, £2,500 (nil); forward, £8,770 (£8,376).

ASSOCIATED BRITISH ENGINEERING—Net profit for the year to March 31, after tax, £45,699 (£45,631); to general reserve, £50,000 (nil); final dividend of 10%, making 16%, on capital increased by £32,000 (one payment of 12% on smaller capital); forward, £18,616 (£48,079).

ALLIED IRONFOUNDERS—Group trading profit to March 31, £1,714,598 (£1,712,948); balance, £746,510 (£789,636, plus £2,720 balances in subsidiaries' accounts brought in); to development reserve, £150,000 (nil); general reserve, £452,210 (£50,000); reserve for replacement of fixed assets, nil (£200,000); stocks reserve, nil (£150,000); pensions reserve, nil (£50,000); final dividend of 7½% (10%), making 12½% (17½%) on larger capital; forward, £513,401 (£575,003).

FRANCIS MORTON & COMPANY—Net profit for the year ended March 31, £44,796 (£31,980); final dividend of 17½% (12½%), making 25% (20%); over-provided for taxation, £259 (£3,697); refund of war risks insurance premiums, nil (£573); to reserve for deferred taxation liability, due to initial allowances, in respect of previous years, £3,800 (nil); further plant and machinery depreciation, £2,000 (nil); buildings depreciation, £4,000 (nil); general reserve, £10,000 (£15,000); forward, £56,581 (£54,701).

WHESSOE—Trading profit to March 31, £295,349 (£347,485); net profit, £79,762 (£126,550); cost of new capital issue, £6,410; transfer from share premium account, £3,641; provisions no longer required—tax nil (£45,000), deferred repairs nil (£5,787); to reserve for works past-service pensions, £15,000 (nil); buildings and plant replacement reserve, nil (£50,000); general reserve, nil (£75,000); final dividend of 15%, making 20%, on £500,000 capital (final dividend of 30%, making 40%, on £200,000); forward, £53,929 (£52,436).

F. H. LLOYD & COMPANY—Group trading profit for the year ended March 31, £315,559 (£273,698); net profit, £156,182 (£132,872 plus £3,443 provision by subsidiary no longer required); to provision for income tax, 1948-49, nil (£21,134); general reserve, £75,000 (£27,064); reserve for increased cost of replacement of fixed assets, £25,000 (£50,000); dividends to outside interests, £412 (£447); dividend of 12½% (10%); forward, £56,936 (£35,679), of which £35,236 (£22,985) is attributable to holding company.

AMBROSE SHARDLOW & COMPANY—Trading profit to March 31, £251,443 (£196,878, including £168 interest on tax-reserve certificates, £1,461 interest on war-damage claim, and £4,697 excess of war damage recovery over book value of assets destroyed); net profit, £173,621 (£106,546, plus £66,000 adjustment to value of work in progress); to stock reserve, nil (£66,000); additional cost of replacement of fixed assets, £50,000 (same); general reserve, £100,000 (£30,000); final dividend of 10%, making 12½% (same); forward, £34,661 (£30,290).

PEASE & PARTNERS—Group trading profit for the year to March 31, £274,266 (£257,120); investment income, etc., £53,765 (£71,996); interim income under the Coal Act, 1946, nil (£240,855); interim income under the Coal Act, 1949, £100,177; retained in subsidiaries' accounts £2,393 (£72,437), Pease & Partners £131,955 (£159,352); future taxation of subsidiaries, £40,000 (nil); preference dividend, nil (£34,100); ordinary dividend, £71,977 (£95,969); forward—subsidiaries £442,711 (£480,318), Pease & Partners £409,602 (£349,624).

JOHN THOMPSON—Consolidated trading profit for 1949, £837,377 (£721,530); balance, £312,174 (£334,927); profit on sale of plant, £1,241 (nil); adjustments in respect of previous years, £530 (£17,154); transfer from general reserve by a subsidiary, nil (£774); to loss on realisation of investments, £2,806 (£5,477); dividends, £79,447 (£77,091), including 17½% (22½%) on increased capital; to investment reserve, £55,325 (£1,050); contingencies, £3,000 (£5,000); general reserve, £75,0000 (£175,0000); bad debts reserve, nil (£1,700); forward, £556,834 (£458,467).

PARTRIDGE JONES & JOHN PATON—Consolidated working profit to March 31, £86,953 (£102,467); net profit, £68,127 (£73,705); interim income, gross, Coal Industry Nationalisation Act, Section 22—no previously ascertained—nil (£7,179); deferred repairs claims 1946-7 and 1947-8, nil (£37,479); income in respect of previous years, nil (£1,143); dividend of 5% (same); goodwill, £4,400 (£10,747); dilapidations reserve, nil (£165); adjustment pension premiums for past years, £2,393 (nil); off cost of shares in sub-subsidiaries, £1,650 (nil); forward, £351,276 (£350,612).

HARLAND & WOLFF—Group profit on trading for 1949, £1,316,741 (£1,446,207); net profit, £679,461 (£758,194); contingencies no longer required, nil (£370,000); surplus on realisation of fixed assets, £68,000 (nil); to pensions for senior executives, £8,561 (£186,733); dividend of 7% (same); directors' fees, £5,950 (£6,077); profits attributable to minority interests, £3,533 (£27,625); balance for year, £495,818 (£674,160); replacement set aside out of profits, previously treated as depreciation, nil (£1,000,000); capital expenditure replacement, etc., £495,818 (£674,160); forward, £3,357,376 (£2,861,558).

CHARLES CLIFFORD & SON—Consolidated trading profit for 1949, less losses of subsidiaries, £70,195 (£115,241); net profit, £28,031 (£40,135); attributable to shares in subsidiaries held outside group, £530 (£387); net profit attributable to company, £27,501 (£39,748); to general reserve, £15,000 (nil); stock reserve, nil (£26,268); staff pensions, nil (£10,000); interim dividend of 1s. per share, tax free, £3,000 (same); final dividend on capital as increased to £100,000 by bonus issue of 1s. 6d. per £1 unit, tax free (second interim dividend of 2s. 6d. per share, tax free, on £60,000), £7,500 (same); forward, £44,567 (£43,556).

HARLAND ENGINEERING COMPANY—Consolidated trading profit for 1949, incorporating South African subsidiary for 18 months and new Canadian subsidiary for two months, £112,911 (£128,347); balance, £46,738 (£46,088); to additional provision for deferred repairs and rehabilitation plant and buildings, £2,500 (same); plant replacement, research, and contingencies reserve, £8,000 (£20,000); general reserve, £10,000 (same); dividends—preference old shares £4,950 (same), preference new shares £1,513 (nil), ordinary old 7% (same), and new £642 (nil); forward, £28,531 (£17,098).

WOODALL-DUCKHAM VERTICAL RETORT & OVEN CONSTRUCTION COMPANY (1920)—Group trading profit for 1949—including one subsidiary for 15 months—£438,046 (adjusted £269,405); net profit of subsidiaries attributable to outside interests, £21,132 (£8,656); profit appropriate to holding company, £149,572 (£89,145); proportion accruing before acquisition of new subsidiary, £678 (nil); brought in, £14,243 (nil); profit carried forward by subsidiaries as general reserve, £98,055 (£34,528); as profit and loss, £10,477 (£14,152); profit accounts holding company, £54,605 (£40,465); to preference dividend, £11,000 (£2,750 for three months); ordinary dividend of 15% (same); forward, £15,320 (£4,715).

New Trade Marks

"ELMET"—Bearing metals. CUTANIT, LIMITED, 50, Gresham Street, London, E.C.2.

"ENGLISH ROSE"—Metal sinks. C. S. A. INDUSTRIES, LIMITED, Avon Works, Wharf Street, Warwick.

"DURAPANEL"—Fireproof steel doors. DURASTEEL ROOFS, LIMITED, 415, Oldfield Lane, Greenford (Middx).

"MARBAT"—Foundry requisites. MARSDEN & BATESON, LIMITED, 67, Scholefield Street, Nechells, Birmingham, 7.

"AGA-MATIC"—Cooking stoves, and boilers. AGA HEAT, LIMITED, Orchard House, 30, Orchard Street, London, W.1.

"MULTICO"—Machinery and machine tools. THE KINE ENGINEERING COMPANY, LIMITED, The Drive, Horley (Surrey).

"RIVALOY"—Metal alloy omnibus bodies. SAUNDERS ENGINEERING & SHIPYARD, LIMITED, Fryars, Beaumaris, Anglesey.

"BODA"—Unwrought or partly-wrought aluminium. UNITED ANODISING, LIMITED, 50, Gresham Street, London, E.C.2.

"TORWOOD"—Stoves, cooking apparatus and water heating appliances. JONES & CAMPBELL, LIMITED, Torwood Foundry, Larbert.

"RECIPROMAC"—Vibrating machines. CHARLES CRUCKSHANK (ENGINEERS), LIMITED, 9, Arthur Street, Leith, Edinburgh, 6.

"MACKHAUL" and "MACKROLL"—Textile machinery. JAMES MACKIE & SONS, LIMITED, Albert Foundry, Springfield Road, Belfast.

"WOLF" AND DEVICE—Portable electric machines. WOLF ELECTRIC TOOLS, LIMITED, Pioneer Works, Hanger Lane, London, W.5.

Increases of Capital

Details of increased capital have been announced by the following companies:—

ARTHUR BALFOUR & COMPANY, LIMITED, steel manufacturers, etc., of The Wicker, Sheffield, 3, increased by £300,000, in 10s. ordinary shares, beyond the registered capital of £150,000.

JOHN THOMPSON (WOLVERHAMPTON), LIMITED, boiler manufacturers, etc., of Ettingshall, Wolverhampton, increased by £249,000, in £1 shares, beyond the registered capital of £1,000.

METAL SCRAP & BY-PRODUCTS, LIMITED, Orchard Place, London, E.14, increased by £25,000 in 15,000 5 per cent. redeemable cumulative preference and 10,000 ordinary shares of £1 each, beyond the registered capital of £5,000.

DARTMOUTH MANUFACTURING COMPANY, LIMITED, manufacturers of range boilers, etc., of West Bromwich, increased by £30,000, in 304,040 ordinary and 295,960 unclassified shares of 1s. each, beyond the registered capital of £20,000.

Raw Material Markets

Iron and Steel

Pig-iron production fluctuates within very narrow limits. Outputs are passing promptly into consumption and, being barely sufficient for current needs, leave no scope for additions to the stockpiles. Probably the position will become easier during the next few weeks—the peak period of the workers' holidays—when deliveries to the foundries are usually suspended or curtailed. This may enable producers of low- and medium-phosphorus iron to overtake the demand for these grades. Big tonnages of hematite and refined irons are being regularly absorbed, and supplies of high-phosphorus iron are by no means excessive.

Sheet bars and slabs are in steady request, and fully to satisfy the needs of the trade home production has to be supplemented by moderate tonnages of imported material. There is also a very strong demand for small, square, and flat billets, but other descriptions are freely offered and sellers have to face keen foreign competition in many markets.

Productive capacity is now so high that a steady flow of specifications is imperative to assure uninterrupted operation of the rolling mills. Happily, works have an impressive volume of orders in hand and are able to arrange their rolling programmes on the most economical basis, which means infrequent roll changing. Apart from steel sheets, of which there is a perpetual shortage, the call for plates is most insistent, and some big orders are in hand for heavy-flange beams, joists, and sections. Rail mills are fully employed. Collieries are taking up fairly large tonnages of props, arches, and roofing bars, and wire mills have all the business they can handle at present.

Non-ferrous Metals

Events in the tin market have been so spectacular that everything else has tended to recede into the background. Although consumers in the U.K. did not take any abnormal tonnage of tin, buying elsewhere was very brisk and demand from the Continent was heavy. America, too, bought substantial quantities of the metal and the price in New York climbed daily in line with the appreciation in London. Fears that the events in Korea and perhaps intensification of the trouble in Malaya could bring about a shortage in supply were probably the main reason for the semi-hysterical rush to buy tin in London, but it would appear that some of the Continental countries were short of it.

Metal Exchange official tin quotations were as follow:—

Cash—Thursday, £685 15s. to £686; Friday, £724 15s. to £725; Monday, £685 10s. to £686; Tuesday, £691 10s. to £692; Wednesday, £661 10s. to £662 10s.

Three Months—Thursday, £685 10s. to £686; Friday, £723 15s. to £724 5s.; Monday, £685 5s. to £685 10s.; Tuesday, £691 5s. to £691 10s.; Wednesday, £661 5s. to £661 15s.

There was a rise in the lead price last week from 11 to 12 cents in the United States, the change coming in two moves of 50 points, and each upward adjustment brought an increase of £4 in London. Lead, therefore, is now quoted at £96, the level at which it stood a few weeks ago. It is fairly generally assumed that in view of the serious situation in Korea the American authorities may abandon their intention of easing up on the stockpiling of lead and it is not impossible that we shall see a further appreciation in the price.

Last week, the Ways and Means Committee of the U.S. House of Representatives approved a Bill suspending the operation of the 2 cents duty on imported copper for 12 months to June 30, 1951. When one considers the statistical position in copper across the Atlantic it is all the more surprising that the duty was reimposed. Figures published by the Copper Institute show that at June 30 stocks of refined copper in producers' hands were no more than 50,327 tons, compared with 51,020 tons at the end of May. In fact, the June total was the lowest since October, 1944. Deliveries to consumers confirm the active conditions which obtain in America, for at 126,047 short tons there was an advance of more than 12,000 tons on the May figure. It is reasonable to assume that stockpiling will be pursued energetically, and in this connection it is likely that the scaling down of operations in lead will be abandoned.

The Ministry of Supply increased the premiums, as from Tuesday last, for refined and electrolytic zinc and zinc of not less than 99.99 per cent. purity, as follow:—Refined and electrolytic zinc, £4 10s. (old premium 15s.); not less than 99.99 per cent. purity, £10 10s. (old premium £2 5s.). The price of G.O.B. "Prime Western" and debased is unchanged. The prices of zinc metal sold by the Ministry a long ton delivered buyer's premises are therefore:—G.O.B. "Prime Western" and debased, £127 10s.; refined and electrolytic, £132; not less than 99.99 per cent. purity, £138.

These changes reflect the increased cost of supplies of high-grade zinc in world markets and will bring the premiums more into line with general practice in the United States and other countries.

House Organs

Ad Rem, Vol. 1, No. 1. Issued by the Butterley Company, Limited, Ripley, Derbyshire.

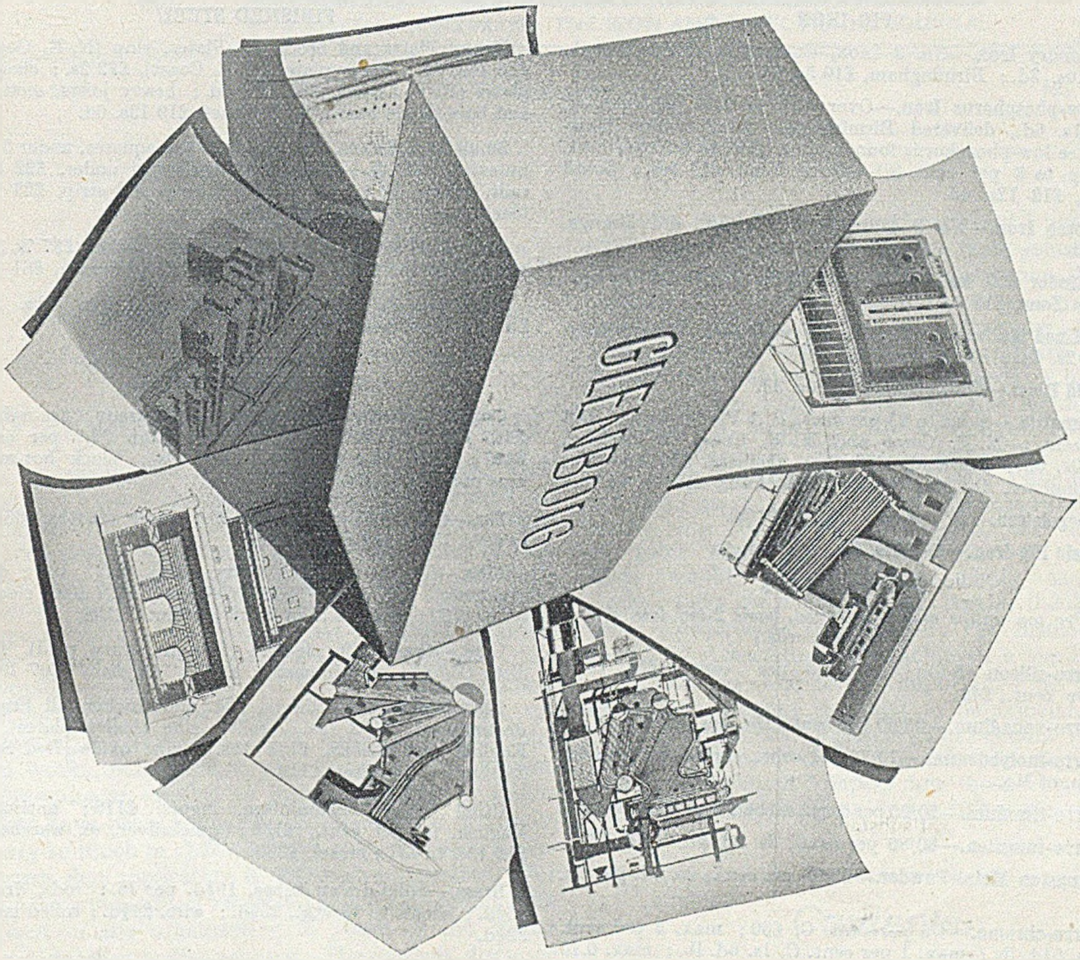
The reviewer believes that subsequent issues will be different from this initial effort. They will be more interesting for the staff and probably of less interest to the outsider. This first issue is of real merit and a start has been made by reprinting an article on the Butterley Works which appeared in the technical Press of 50 years ago. Then there is an article on Meehanite, a material for which Butterley hold a manufacturing licence. Amongst other activities described is a large farm belonging to the Company where the products of the agricultural machinery department can be tested out. Then there is a page of puzzles, but the most vexing of all is why the magazine is called Ad Rem—which is, if the reviewer's Latin is not at fault, "To the point." Yet one could scarcely expect the average workman to know this.

Broomwade News Bulletin, Vol. 13, No. 2. Published by Broom & Wade, Limited, High Wycombe.

This issue carries on its front page an illustrated description of the firm's stand at Castle Bromwich. The reviewer suggests that the article on the New Delhi Industrial Exhibition should have taken pride of place, as having greater publicity value on account of the illustrations. Moreover, overseas markets make better news to-day. The balance of make-up is high-grade and well maintains the standard this firm has set for itself.

S. & W. Magazine, Vol. 4, No. 7. Issued by Smith & Wellstood, Limited, Bonnybridge, Scotland.

This issue announces the departure of five executives who are to form the nucleus of the staff to operate at Springs, Transvaal, the new works of Smith & Wellstood (Pty.), Limited. In future, this house organ is to be published quarterly.


GLENBOIG

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

(Delivered, unless otherwise stated)

July 19, 1950

PIG-IRON

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

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

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

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

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

Cold Blast.—South Staffs, £16 3s. 3d.

Hematite.—Si up to 2½ per cent., S & P over 0.03 to 0.05 per cent.:—N.-E. Coast and N.-W. Coast of England, £12 0s. 6d.; Scotland, £12 7s.; Sheffield, £12 15s. 6d.; Birmingham, £13 2s.; Wales (Welsh iron), £12 0s. 6d.

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

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

FERRO-ALLOYS

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

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

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

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

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

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

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

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

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

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

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

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

SEMI-FINISHED STEEL

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

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

Sheet and Tinplate Bars.—£16 16s. 6d.

FINISHED STEEL

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

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

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

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

NON-FERROUS METALS

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

Tin.—Cash, £661 10s. to £662 10s.; three months, £661 5s. to £661 15s.; settlement, £662

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

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

Zinc Sheets, etc.—Sheets, 10g. and thicker, all English destinations, £143 15s.; rolled zinc (boiler plates), all English destinations, £141 15s.; zinc oxide (Red Seal), d/d buyers' premises, £119.

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

Brass.—Solid-drawn tubes, 19⅝d. per lb.; rods, drawn, 25⅝d.; sheets to 10 w.g., 23⅞d.; wire, 24⅜d.; rolled metal, 22⅝d.

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

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £129 to £136; BS. 1400—L.G.3—1 (86/7/5/2), £138 to £143; BS. 1400—Gl—1 (88/10/2), £181 to £239; Admiralty GM (88/10/2), virgin quality, £190 to £237, per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £200-£240; L.P.Bl, £140-£154 per ton.

Phosphor Bronze.—Strip, 31½d. per lb.; sheets to 10 w.g., 33⅜d.; wire, 33d.; rods, 31d.; tubes, 36¼d.; chill cast bars: solids, 32¼d., cored, 33¾d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Ingots for raising, 2s. 1¾d. per lb. (7% to 3s. 1¼d. (30%); rolled metal, 3 in. to 9 in. wide × .056, 2s. 7¾d. (7%) to 3s. 7¼d. (30%); to 12 in. wide, × .056, 2s. 8d. to 3s. 7½d.; to 25 in. wide × .056, 2s. 10d. to 3s. 9½d. Spoon and fork metal, unsheared, 2s. 4¾d. to 3s. 4¼d. Wire, 10g., in coils, 3s. 1¼d. (10%) to 4s. 0¾d.; (30%). Special quality turning rod, 10%, 3s. 0¼d.; 15%, 3s. 5d.; 18%, 3s. 9½d.