FOUNDRY TRADE JOURNAL

Established 1902

Vol. 91 Thursday, October 4, 1951 No. 1831

PRINCIPAL CONTENTS

PUBLISHED WEEKLY: Single Copy, 9d. By Post 11d. Annual Subscription, Home 40s., Abroad 45s. (Prepaid).

49, Wellington Street, London, W.C.2. 'Phone: Temple Bar 3951 (Private Branch Exchange) Grams: "Zacatecas, Rand, London"

Revolutionary Alloy?

At the recent International Foundry Congress in Brussels, no fewer than ten papers were presented on the subject of ductile cast iron, four emanating from the staff of the nickel research and information bureaux in America, France, Belgium and Italy. Thus ample opportunity was given both for assessing the present position and future prospects. Gagnebin was enthusiastically optimistic—an attitude not altogether supported by other experts. One lecturer summed-up the situation as follows:—

Where the demand is for light, thin-section castings, then generally speaking malleable-iron castings will meet the requirements. As the sections get thicker, then there is a choice between steel and ductile irons. At the moment, there is little difference in cost, except perhaps reduced fettling for ductile iron. Where, however, there is much machining to be carried out, then nodular iron shows up to advantage. The making of nodular is not easy, as suitable raw materials are not everywhere readily available. Trace elements can cause endless trouble. For the future, our informant considered that there was a chance that the alloys used may become cheaper. (We hope this will have no detrimental repercussions like a Minister's recent statement on woollen goods!). It is now established that ductile iron has found a niche—and an important niche—in the engineering industries. This will extend, but nodular iron is not one which is going to revolutionise either foundry or engineering practice, though it most certainly will make an important contribution to progress.

The optimistic American lecturer who prophesied that "spheroidal cast iron will become the second ranking material in the foundry, exceeded in tonnage only by grey iron" is contrary to our conception which is that it will occupy the present position of tool steel *vis-à-vis* with the general steel industry. He envisages its use in the lesser industrialised countries of the world, owing to the simplicity of the plant and process. In one place he states that it is easier to make than acicular iron —but surely he has chosen one of the most difficult irons to manufacture consistently when the sectional thickness is not uniform. One thing is certain, and that is that the research done in connection with nodular iron has very naturally added to our knowledge of cast iron, or, in the words of Rehder, "The discovery and subsequent study of the nodular cast irons has had a beneficial effect on the whole field of the cast irons, in that it has not only emphasised our general ignorance of the metallurgy and mechanisms in these complicated systems, but has made more apparent the general family resemblances, if not metallurgical identity of grey cast irons, malleable irons and nodular irons." This is the real revolution.

I.B.F. Golfing Society

The Golfing Society of the Institute of British Foundrymen held its sixth annual golf meeting at Woodhall Spa last Saturday and Sunday, September 29 and 30. Although early morning mist held up play on both mornings, the sun soon came out and most of the play was in brilliant weather, with the result that the scoring was very good.

Saturday morning's play.—Stroke competition for the I.B.F. handicap and scratch cups:—

Results: (1) P. B. Higgins, 84 − 12 = 72, winner of handicap cup.
(2) E. W. Pugh, 80 − 7 = 73, winner of scratch cup.
(3) P. G. Pennington, 85 − 12 = 73.
(4) H. C. Hanson, 95 − 22 = 73.
(5) R. S. Darby, 89 − 13 = 76.
(6) L. A. Bailey, 86 − 9 = 77.
(7) S. J. Kerr, 89 − 12 = 77.
(8) F. Dunleavy, 103 − 25 = 78.
(9) R. C. Shepherd, 92 − 14 = 78.
(10) W. H. Richards, 96 − 17 = 79.

There were 38 competitors. In addition to holding the cups for a year, the respective winners also received a tankard each kindly presented by Mr. J. J. Sheehan, immediate past-president of the Institute.

Saturday afternoon.—Greensome foursomes *v.* bogey:

Winners: W. J. W. Proctor and W. H. Richards, 3 up.
(2) R. C. Shepherd and D. Carrick, 3 up.
(3) J. Ainsbury and C. H. Wilson, 3 up.
(4) P. G. Pennington and H. C. Hanson, 3 up.

The above places were decided on the second nine holes. The winners each received a "Lincoln Imp," kindly presented by Mr. R. C. Shepherd and Mr. A. Swain, of Ruston & Hornsby, Limited.

Sunday morning.—Four-ball foursomes *v.* bogey:—

Winners: R. B. Templeton and R. C. Shepherd, 8 up.
(2) E. W. Pugh and W. H. Richards, 6 up.
(3) P. G. Pennington and R. S. Smeeth, 5 up.
(4) P. B. Higgins and G. R. Nicholls, 5 up.
(5) W. E. Aske and H. Oliver, 5 up.

The winners received half-a-dozen golf balls each, kindly presented by Mr. F. Webster, of Augusts, Limited.

At the annual meeting of the Golfing Society, which followed, with Mr. R. B. Templeton in the chair, the prizes were presented by Mr. Colin Gresty, president of the Institute, and the following office-bearers for next season were elected:—*As president,* Mr. R. B. Templeton; as *committee,* Mr. E. Arthur Phillips, Mr. J. Bell, and Mr. F. Arnold Wilson (hon. secretary); and as *vice-presidents,* Mr. P. H. Wilson, Mr. V. C. Faulkner, and Mr. R. C. Shepherd.

In addition to 38 competitors, wives and spectators numbered 26, and Dr. Dadswell, senior vice-president of the Institute, Mrs. Dadswell, and their daughter joined the party for luncheon on the Saturday. This was by far the most successful golf meeting so far held, and it was unanimously decided to hold the 1952 meeting on the corresponding week-end at the same course, in view of its excellence and the good amenities offered by the Golf Hotel.

Light for Travelling Circus

The "Ruston News" reports that in connection with the present visit to Lincoln of Billy Smart's Circus, it is of interest to note that the electricity for power and light at the circus is generated in a mobile power station of 250 kw., which is equipped with Ruston engines made in Lincoln. It is thought to be the largest power plant of its kind in the country, and has been "on the road" for two years. It is capable of providing light for a town of 20,000 inhabitants.

Conference Paper Authors

D. T. Kershaw, B.Sc., is co-author with Mr. Nicholls of the Paper "A System of Studying Casting Defects" (printed on page 383). Mr. Kershaw was educated at Heath Grammar School, Halifax, and served his apprenticeship at Modern Foundries, Limited. He was awarded the B.Sc. degree at the age of 22 after studying part-time at the Halifax Technical College. In 1948 he was appointed chief chemist of Modern Foundries, Limited. Mr. Kershaw presented a Paper, in 1949, on oil-sand practice to the West Riding of Yorkshire Branch and the Slough Section of the Institute.

Mr. D. T. Kershaw.

Mr. G. W. Nicholls.

G. W. Nicholls, who is co-author with Mr. Kershaw of the Paper "A System of Studying Casting Defects," is manager and metallurgist of Modern Foundries of W. Asquith's, Limited, Halifax. Born in 1911, Mr. Nicholls was educated at Rutherford Technical College and served his apprenticeship in the laboratory and foundry of the North Eastern Marine Engineering Company, Limited, Wallsend-on-Tyne. Subsequently, he served for nine years in the technical and research department of A. Reyrolle & Company, Limited, Hebburn-on-Tyne. He joined Modern Foundries, Limited, in 1940 as chief chemist and assistant manager, and was promoted to his present position in 1945. He first joined the Institute as a junior member in 1928 and rejoined as a member of the West Riding Branch in 1941. He was awarded a diploma of the Institute in 1944, and has presented papers to many branches of the Institute. He has been a representative of the West Riding Branch on the Technical Council since 1944, and has served on a number of technical sub-committees.

Plaster of Paris

We recently had a visit from the sales manager of a company making plaster of paris; from him we learnt that some 15 million tons of gypsum were being mined yearly in this country. A second interesting fact was that one of his U.K. customers buys each year 700 tons of plaster for dental moulds. Naturally, the conversation turned to foundry uses, and here the range is very wide. It is used for plaster patterns, for odd-sides, for actual moulds in the brassfoundry and precision-casting trades. He thought his firm could make a contribution to the problems of the utilisation of refractory plaster.

Plans have been approved for extensions costing £19,000 to the Falkirk (Stirlingshire) plant of the British Aluminium Company, Limited.

System of Studying Casting Defects*

By G. W. Nicholls and D. T. Kershaw, B.Sc.

Although a good deal of modernisation has been carried out in the foundry industry with the object of improving production methods, it is considered that sufficient time and thought has not been given to the matter of reducing scrap and defective castings, largely because of the generally-accepted view that defective castings must be expected. No great concern is shown so long as the percentage of castings appears to be within reasonable limits, but it must be admitted that by careful control of all foundry operations it should be possible to reduce appreciably the accepted limit.

The general position in the foundry industry to-day, consequent upon shortages of materials and labour, makes it essential to reduce scrap and defective castings to the lowest possible figure. Managements, who hold full responsibility, must be considered as the main key to the foundry's success in the production of sound castings. Progress achieved in this direction can usually be measured by the management's attitude and the amount of energy expended by the staff towards the elimination of scrap and defective castings. It can be said that the amount of scrap produced in any foundry is inversely proportional to the attention paid to the problem by the management and to the efficiency of the quality-control staff.

CONTROL SYSTEM

In the jobbing foundry with which the Authors are associated, castings weighing from ounces up to 30 tons are made by hand-ramming, Sandslinging and machine-moulding methods. In some cases, particularly in respect of heavy castings, quite a number are made by floor-moulding methods at a rate of only two per year. Consequently, any difficulties which occur during the production of the first casting are likely to recur during the production of subsequent castings, particularly if the moulder, coremaker and foremen are not familiar with all facts regarding the history and quality of the first casting made. Further, a large number of running-line castings, approximately one ton in weight, are made by machine-moulding methods at the rate of six to eight per day. These castings are usually weathered in the stockyard for periods up to six months. Therefore, any variables which creep into the production methods or materials may result in a large percentage of scrap or defective castings being brought to light after a considerable lapse of time. In addition, the foundry is operating on an individual piece-work system, producing approximately 30 tons of casting per employee, or 110 tons per moulder per annum. The variable human element, therefore, comes in to a much greater extent than in a foundry working a day-work system.

It was for the above reasons that the following system of studying casting defects or any difficulties encountered in the production of machine-tool castings was begun, and later enlarged, to cover almost all castings produced in the foundry.

* Paper presented at the Newcastle-upon-Tyne Conference of the Institute of British Foundrymen, with Mr. E. Longden in the chair.

At the commencement of the system in 1944/45, it was decided that the value of thorough control of all defective work could not be too strongly emphasised. The production staff were informed that haphazard methods of investigation could not be tolerated, and that each job would have to be considered in detail from design to the casting operation. It was also agreed that the system should serve three main purposes:—(1) To study and eliminate defective castings; (2) to prevent defective castings arriving at the machine shops, and (3) to supply the foundry with complete details of all defective work in the form of record cards and instruction sheets.

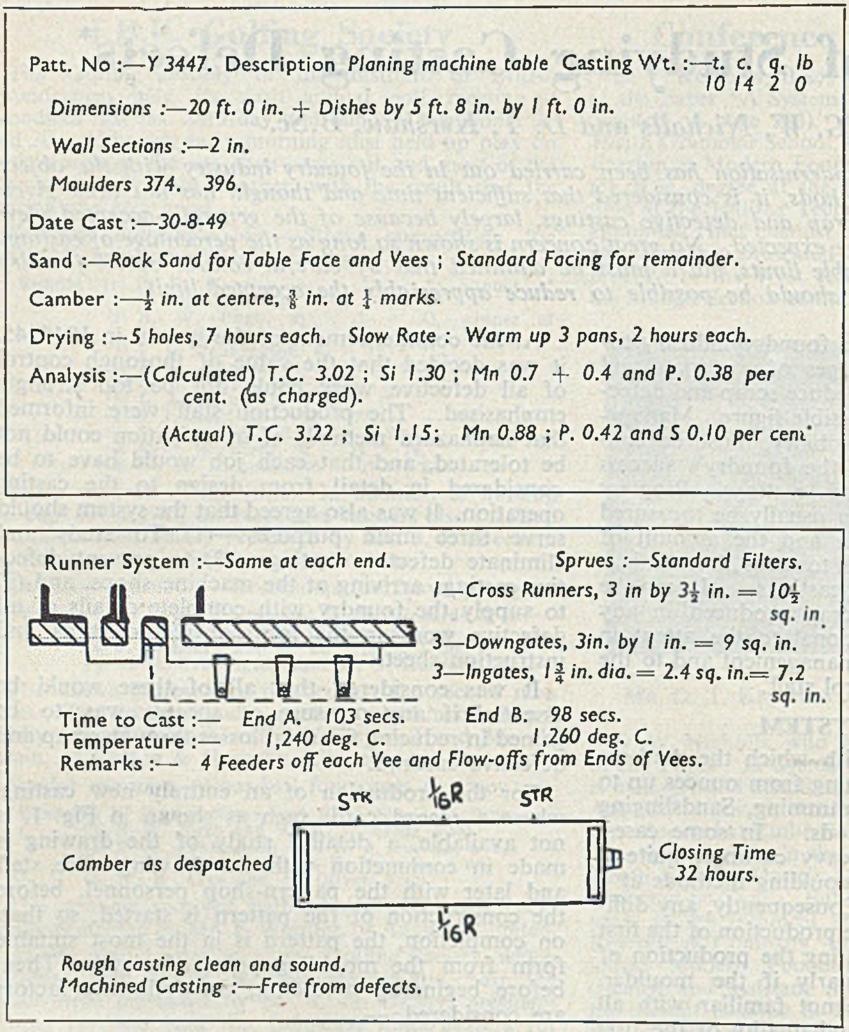
It was considered that all of these would be essential if any measure of success was to be gained in reducing financial losses through scrap and defective castings.

For the production of an entirely new casting, where a record card, such as shown in Fig. 1, is not available, a detailed study of the drawing is made in conjunction with the drawing-office staff and later with the pattern-shop personnel, before the construction of the pattern is started, so that, on completion, the pattern is in the most suitable form from the moulding point of view. Then, before beginning moulding, the following factors are considered:—

(*a*) *Composition of the Metal.*—The composition of the metal to be used is decided upon after consideration has been given to the various metal sections and to the service conditions required from any machined surfaces of the casting.

(*b*) *Methods of gating and feeding.* Given the type of iron to be used, the position, number and size of ingates are then considered, and having been established are painted upon the pattern. Working backwards from the ingates, the dimensions of the remainder of the gating system—downgates, runner bars and sprues—are decided upon, together with the location and nature of any dirt traps to be included. The number, type and sizes of feeders necessary to supply liquid metal to the solidifying casting are also considered and their positions marked on the pattern. The necessity for chills or denseners to assist in the production of sound metal sections is also considered for assisting towards the achievement of the foundryman's dream—progressive solidification.

(*c*) *Camber.* If the casting is of such size and design that camber is necessary in the moulding, the



Patt. No :—Y 3447. Description *Planing machine table* Casting Wt. :—t. c. q. lb 10 14 2 0

Dimensions :—20 ft. 0 in. + Dishes by 5 ft. 8 in. by 1 ft. 0 in.

Wall Sections :—2 in.

Moulders 374. 396.

Date Cast :—*30-8-49*

Sand :—*Rock Sand for Table Face and Vees ; Standard Facing for remainder.*

Camber :—*½ in. at centre, ⅜ in. at ¼ marks.*

Drying :—*5 holes, 7 hours each. Slow Rate : Warm up 3 pans, 2 hours each.*

Analysis :—*(Calculated) T.C. 3.02 ; Si 1.30 ; Mn 0.7 + 0.4 and P. 0.38 per cent. (as charged).*

(Actual) T.C. 3.22 ; Si 1.15; Mn 0.88 ; P. 0.42 and S 0.10 per cent

Runner System :—*Same at each end.* Sprues :—*Standard Filters.*

1—Cross Runners, 3 in by 3½ in. = 10½ sq. in.

3—Downgates, 3in. by 1 in. = 9 sq. in.

3—Ingates, 1¾ in. dia. = 2.4 sq. in.= 7.2 sq. in.

Time to Cast :— *End A. 103 secs. End B. 98 secs.*

Temperature :— *1,240 deg. C. 1,260 deg. C.*

Remarks :— *4 Feeders off each Vee and Flow-offs from Ends of Vees.*

Camber as despatched *Closing Time 32 hours.*

Rough casting clean and sound.

Machined Casting :—Free from defects.

FIG. 1.—*Back and Front Views of Standard Record Card, one of which is Completed for Each New Job Made.*

amount and distribution of camber to be given to the mould to ensure a straight casting, is determined.

(*d*) *Sand.* Four grades of facing sand are used for regular production, each suitable for a particular type of casting, and the grade most suitable for a new casting is decided upon.

(*e*) *Mould drying.* Most of the medium, and all the heavy castings are produced in dry-sand; moulds being dried *in situ* by means of portable coke-fired hot-air dryers, or by batch-type drying ovens. Therefore, when ramming the cope of heavy floor-moulded work, provision has to be made for the inclusion of the drying holes; *i.e.*, holes through which hot air may be introduced into the mould. A decision has to be made regarding the number and position of these drying holes.

(*f*) *Moulding technique.* Having decided upon the above factors, the moulder's attention has to be drawn to any part of the mould requiring particular attention to detail such as venting, sprigging, ramming, etc., in an endeavour to minimise the risk of producing defective castings. On completion, the mould is stamped with the date when cast, so that any defects which appear during the machining of the casting may be traced back by referring to the conditions under which the mould was made. The time taken to pour the casting and the temperature of the metal used are also recorded on the card (Fig. 1).

Apart from the recording system, inspection has also been established to cover mould cleanliness and dryness. Properties of sands are controlled to obtain a satisfactory combination and this condition is checked daily and sometimes twice daily. Moulders and coremakers are instructed as to the requirements to be observed in the moulding operation, with special reference to venting, gating and feeding technique, and, in addition, all moulding and coreing operations are standardised. The conveying of such information to the operators is of the greatest importance in this control system and a process sheet giving brief instructions on all important points, such as the type of sand to be used, special moulding features, type of gating and the number of drying holes required, is issued along with the order for the job to the foreman (Fig. 2).

After the casting has been completed in accordance with the instructions issued to the foreman moulder, the next stage is a thorough examination of the fettled casting by the quality-control staff, and the recording of their findings on the record card. Any action necessary to improve the quality of the casting is then taken.

The machining operations having been completed, a member of the staff makes regular routine tours of the machine shops and reports on any visible defects on the castings examined; this report being in the form illustrated in Fig. 3. The results of the action taken to rectify any defects on subsequent castings is observed and the necessary information added to the standard record card.

At the commencement of the system, it was realised that the laboratory staff would have to perform a large part of the work involved, and they were, therefore, trained for this purpose and gradu-

FOREMAN'S INSTRUCTION SHEET

20th October, 1950.

Planing Machine Bed.

Length ... ... 23 ft. Vees (centre section)
Depth ... ... 2 ft. 3 in.
Width ... ... 5 ft. 3 in. (7 ft. 5 in. across cheeks)
Camber ... ... ¾ in.—1 ft. 6 in. off centre

In addition to carrying out normal good moulding practice, please adhere to the following instructions :—

(1) Set camber according to sheet issued by laboratory ; camber to be checked by laboratory.
(2) Use 2 in. dia. ingates into ends of each vee, and 3 in. by 1¼ in. down runners.
(3) Use 4 in. by 3 in. cross runners (rammed up) with slag traps at junction with down runners.
(4) Thoroughly vent mould all round pattern.
(5) Make five standard drying holes, end holes to be 1 ft. 6 in. from each end of mould.
(6) Use 4 in. dia. sprue.
(7) Take flow-offs from each bolting-down lug.
(8) Take vent from each trough core to coke bed.
(9) Use threaded stalks, fluxed with red lead, for holding down tank cores.
(10) Use no chaplets along the machined oil trough.
(11) Use dry-sand pouring basins.
(12) Inspect all cores on day prior to coring

FIG. 2.—*Replica of a Foreman's Instruction Sheet, one of which is issued with the Order for each New Job.*

ally made responsible for maintaining the standard and quality of castings produced in the foundry. They are also responsible for taking all necessary action to assist in preventing defective work from reaching the machine shops. If defects are brought to light, the laboratory staff record full particulars and then investigate their cause or causes and take any action necessary for their elimination on future runs.

A further responsibility is that of submitting data to the foundry, this data being taken from the record cards. The value of this part of the work (the compiling of records of all defective and scrap castings), in most cases, is insufficiently recognised.

Value of Record Cards

The information on these records serves two useful purposes, (*a*) it tells the management the basic causes of scrap and (*b*) enables the foundry in the shortest possible time to correct defects reported. It has been found that where defects are not properly diagnosed, much time is spent on incorrect remedies. In order to carry out proper diagnosis of defects, therefore, the laboratory staff must be properly trained and hold frequent consultations with the foundry foremen so that the records combine the judgment of both departments.

In launching this system it was further borne in mind, that one of its objects would be to eliminate haphazard methods of investigation and that in every case where an investigation was necessary, it would cover an over-all picture of every phase of the manufacturing process, as any defect can be the result of a number of out-of-balance factors. Therefore, the diagnosis must be tackled by a combination of technical studies, quality-control and laboratory tests.

In order for the system to operate satisfactorily, it is essential that the staff be made scrap conscious and fully trained to specialise in one or more aspects of foundry technology. It is also necessary to have available an adequate supply of testing equipment and to ensure that the whole staff fits effectively into the manufacturing process.

After a careful study of the record cards collected after the first 12 months, it was found that of the castings rejected:—47 per cent. were due to blowholes; 25 per cent. to sand or dirt inclusions; 17 per cent. to shrinkage and metallurgical unsoundness; 6 per cent to mis-runs or cracks and 5 per cent. to miscellaneous causes, *e.g.*, distortion, short-cast, core movement, etc.

From the inauguration of the recording system, the percentage of castings rejected showed a downward trend despite (*a*) the more rigid foundry and machine-shop inspection than during the war years, and (*b*) the increase in the gross output from the same number of operators (see Table I). All the record cards and process sheets are maintained and filed by the laboratory staff. In addition to their use on the present system, they also serve a useful purpose in the training of foundry apprentices, all of whom pass through the laboratory, as part of their training.

DEFECTIVE CASTING.

Report No. *123.*
Date *3-4-50.*

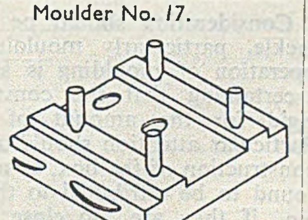
Works Order	Description	Pattern No.
	Planing M/c Table. 12′-0″ between Dishes, 4′-6″ wide. 4″ Metal Section through Flats.	*54 M02*

Coremaker No. :— Moulder No. *17.*

Nature of Defect :—

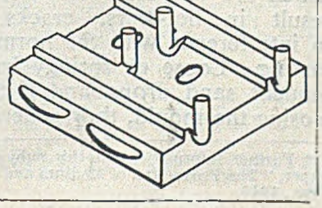
Porosity under Top Feeders Positioned along Flats, and Dirt Inclusions at Ends of Flats.

Sketch (if necessary) :—



Action taken to eliminate defect :—

Side Feeders instead of Top Feeders. Additional Feeders at Ends of Flats.



Result of Action Taken :—

Elimination of Defect.

FIG. 3.—*Defective and Rejected Casting Form; Suitable Corrective Data are Transferred to the Standard Record Card.*

TABLE I.—*Foundry Progress since the Inauguration of the Control System.*

Year.	Gross output of castings.	Nett output of castings.	Foundry wasters.		Machine-shop wasters.		Total wasters.	
			Tons.	Per cent.	Tons.	Per cent.	Tons.	Per cent.
1943/4 ..	4,780	4,480	140½	2.93	166½	3.47	307	6.40
1944/5 ..	3,636	3,427	88½	2.43	120	3.29	208½	5.72
1945/6 ..	4,126	3,930	70½	1.71	124	3.00	194½	4.71
1946/7 ..	4,485	4,272	97½	2.17	115½	2.57	213	4.74
1947/8 ..	4,663	4,412	99	2.12	152½	3.27	251½	5.39
1948/9 ..	5,106	4,849	71	1.39	187	3.66	258	5.05
1949/50 ..	5,229	5,005	106	2.03	118	2.25	224	4.28

Staff Training

The staff, as mentioned previously, are trained to specialise in one or more branches of foundry technology, such as:—(1) Design of castings, pattern construction and preparation of moulding tackle; (2) sand properties and control; (3) mould camber; (4) gating of moulds; (5) feeding of castings; (6) drying processes, and (7) melting and casting operations.

This method of breaking-down the foundry processes into seven groups was done partly because these were found to be the main categories into which to classify defective castings and also because it was further considered that it would be necessary to record all defective work, such as defective moulds, cores unsuitable for use, or metal unsuitable for casting, if complete quality control through the various processes up to the casting stage was to be achieved.

The training of the staff to fit into the organisation was partly achieved by establishing a complete reference library on technical literature published relating to casting defects, carrying out fundamental investigations on foundry problems as they arose and issuing instructional notes on the result of the findings of these investigations.

The way in which the results obtained from investigations and the information contained on the record cards has been used to assist in the elimination of defects, together with the principles involved, is illustrated in the following sections.

Moulding Tackle, Casting Design and Pattern Construction*

Consideration should be given to all moulding tackle, particularly moulding boxes, before the operation of moulding is started, with a view to ascertaining that the construction is sufficiently rigid for the amount of sand to be carried. Particular attention should also be paid to the bar construction of the box, as many defects have been found to be attributed to the design of box bars; *e.g.*, if they are too close to the pattern it may result in loosely and unevenly rammed sand, which is liable to produce scabs or rough surfaces. Bars which are too close to the runners or risers may result in hot-tears, cracks or distortion, due to interference with the normal contraction of the casting. Loose or springy bars can result in subsequent sand drops, and if these take place after closing the mould, they generally result in the casting being a total loss. Pin-holes in the boxes should be checked periodically to ascertain that the centres are accurately maintained, thus avoiding the production of cross-jointed castings.

Many examples can be quoted where a pattern has been made purely as a model, without consideration of feeding or running requirements. Wherever possible, the foundry staff now consult with the drawing office and the patternshop before a design is finalised and before the pattern construction is commenced.

Particular points to be noted in designing are changes in metal sections which are too abrupt, heavy or isolated bosses which may result in porosity or shrinkage cavities, insufficient openings for venting cores, which may result in the trapping of gases in the metal, thus causing blowholes, and internal construction such as ribbing, which may interfere with contraction and result in warped or cracked castings.

Sand

An unsuitable sand condition can produce almost all the defects known to occur in grey-iron castings. Any deviations from previously proved sand properties usually show themselves as blemishes or defects on the surface of the castings produced. Therefore, in order to maintain a steady flow of sound castings it is essential that variations from these proved properties should be eliminated immediately, and not left until a pile of scrap or defective castings bears mute evidence to the necessity.

Although perfect sand control, particularly in a jobbing foundry, can seldom if ever be fully achieved, it is possible to obtain effective control by regular testing of raw materials and mixed sand, and by taking suitable action immediately any discrepancies appear. Variations in sand properties can best be illustrated by a chart of the daily test values (Fig. 4). General tendencies of the different properties can then be observed easily, without having to study long lists of figures. The charts are also valuable for record purposes, since they indicate the properties of the sand used in the moulding of any defective casting which may be produced, provided that the date has been stamped on the mould during its preparation.

Controlling the physical properties of a sand between certain fixed limits, however, does not necessarily mean the elimination of all the defects attributed to sand. Many defects occur through the improper use or treatment of good sand. Furthermore, sand which is suitable for one class of work may cause endless trouble when used for a different type of casting. Thus, in the Authors'

* Further information on this subject is included in a previous Paper, "The Production of Medium and Heavy Iron Castings," *I.B.F. Proc.*, 1949.

foundry, four different grades of facing sand are now in constant use. Each grade is suited to a particular class of casting, ranging from a fine sand for small detail work to a very coarse, heavily-bonded sand for large castings.

The coarse sand was recently incorporated into the standard range as a means of eliminating the blind or dummy scabs which sometimes appeared on heavy castings with large, flat surfaces. Blind scabs may originate from a number of causes, such as improper drying, insufficient clay content for the grain type, too high a moisture content or uneven ramming of the mould surface. From a study of the record cards and sand charts, it was found that a sand with a high compression strength when baked successfully eliminated blind scabs from smaller work, provided that it was not dried so rapidly as to cause cracks to appear on the mould surface. All that appeared necessary to eliminate this defect from large castings, therefore, was a sand with still higher dry-strength. Scottish rotten rock sand with a coarse grain and high clay content was found to be ideal.

Moisture Control

In addition to solving the origin of the defects appearing on castings, the recording system indicates the type of investigation to be carried out with a view to reducing the number of defectives which are likely to appear. Thus, the record cards indicated that a mould which took more than one day to core and close was more likely to show minor sand defects than one which could be closed and cast in one day. This was thought to be due to the increased time which elapsed between drying and casting, which permitted the moisture in the sand behind the dried mould-surface to strike back. Whilst this creeping back of moisture no doubt plays an important rôle in the production of defects, investigation showed that considerable quantities of moisture were also absorbed from the atmosphere.

A series of A.F.S. standard test-specimens was prepared from a sample of mixed facing sand, and baked until the uncombined water had been driven off. After removal from the baking oven, the cores were tested for dry strength at intervals as they cooled to room temperature. Portions of the broken cores were then tested for absorbed moisture by determining the loss in weight after drying at 105 deg. C. The last core was tested three days after removal from the oven. The results obtained from this experiment are shown in Fig. 5. It will be noticed that moisture began to be absorbed by the cooling moulding sand as soon as the temperature had fallen below 100 deg. C., and that as the absorbed moisture increased, the strength of the sand was considerably reduced until, after three days, the absorbed water approached 1 per cent., whilst the strength had dropped to one third of its former value.

It would appear from these results, therefore, that defects produced on moulds, which have stood for an appreciable length of time after drying, are due to the combined effects of the loss in strength, which is known to cause blind scabbing, and to the absorbtion of moisture on the mould surface. Two modifications have therefore been made to the moulding practice for castings taking more than one day to close.

(1) In cases where the cores are all suspended from the cope (*e.g.*, planing machine tables and horizontal boring machine work-plates), the top parts are removed after securing all cores and the mould is warmed up before final closing.

(2) For castings where the above modification is impossible, coring up is carried out by a day and night shift to reduce the standing time.

Figs. 6 and 7 depict the results obtained by extending this investigation to the case of oil- and resin-bonded sands. The strength of an oil-sand was shown to increase progressively as the temperature fell to normal (Fig. 6) due to the setting and hardening of the oil film, but on prolonged standing, a reduction of strength occurred similar to that noted with moulding sand. In obtaining the latter results, the baked cores were stored at a constant temperature (65 deg. F.) with 100 per cent. relative humidity to accentuate any moisture absorption which might occur. The moisture-absorption figures obtained after 16 days' standing were:—Proprietary drying oil, 0.92 per cent.; U.F. resin, 0.92 per cent.; P.F. resin, 0.53 per cent.

Oil-sand cores for large castings may have to be stored for relatively long periods before use, due to the fact that many cores have frequently to be made from the same core-box. In order to obtain the best results, therefore, the absorbed surface moisture is removed, either by returning the cores to the baking oven for a period at a reduced

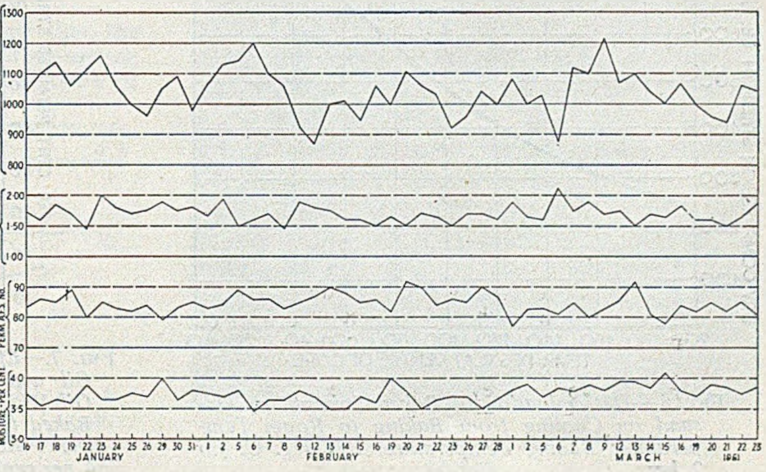


FIG. 4. — *Three-months' Control Chart showing Daily Sand Properties for Oil-bonded Core Sand.*

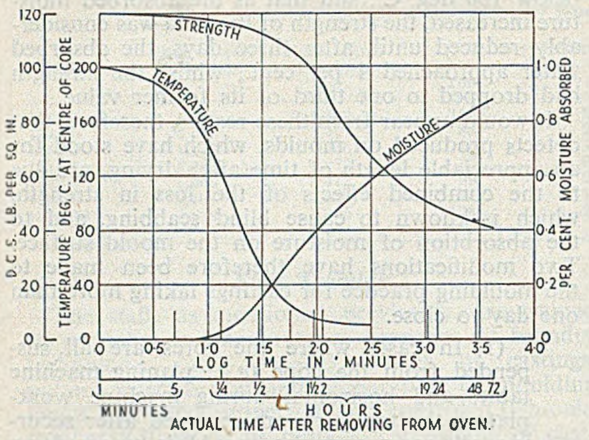


FIG. 5.—*Effect of Temperature and Storage on the Properties of Dried Moulding Sand; Standard Cores were Baked for 1¼ hrs. at 200 deg. C.; Room Temperature was 10 deg. C. and Barometric Pressure 75 cm. Hg.*

temperature, or by making use of the heat contained in a recently-cast mould. In addition to increasing the strength of the core, this warming-up ensures that both mould and cores are at approximately the same temperature and so reduces the risk of condensation taking place. Results obtained from other investigations into the causes of defective castings have already been reported.[1, 2]

CAMBER

Internal stresses, which are present in all but the simplest of castings, arise from a number of causes, the chief of which is the unequal cooling rate of differing sections. Any distortion which occurs because of these stresses is usually not very noticeable with small castings, but as the casting length increases, so is the distortion magnified until it exceeds the machining additions to the pattern.

In the manufacture of sizeable castings, therefore, allowance has to be made for the distortion which will take place on cooling. Until recently, the knowledge of the amount of camber required for the production of straight castings could only be gained from past experience in the production of similar castings. E. Longden,[3] however, in an excellent Paper on the contraction and distortion of iron castings, included a camber graph which describes the camber he found necessary for the castings produced at the foundry with which he was associated. On comparing this graph with the results obtained on similar castings (machine-tool bedplates, tables, etc.) at the Authors' foundry, some slight variations were noticed, which can be explained by the difference in the respective castings. Nevertheless, the graph can be used with confidence once the difference between the types of casting are known.

Adoption of the Camber Graph

The method adopted at the Authors' foundry is to compare the amount of camber called for by the camber graph with the amount given to a casting of similar design to the one being prepared, and to adopt a compromise between the two values after considering the various factors involved. By this method, castings are rarely more than ⅛ in. to ¼ in. distorted, even on a length of 40 ft., providing the strickles used for making the bed of the mould have been set correctly. Incorrect setting of the strickles, it was found, was the most usual cause of distorted castings.

Before the study of distortion was commenced, the camber was set by bedding long wooden strickles into the floor of the casting pit and bending them to the desired camber. One, two or three strickles were used for this purpose, depending on the length of the casting, and the sizes of the strickles most readily available. Also, whilst the moulder was instructed as to the amount of camber to be used, the distribution of the camber along the bed was left to his discretion. It was found

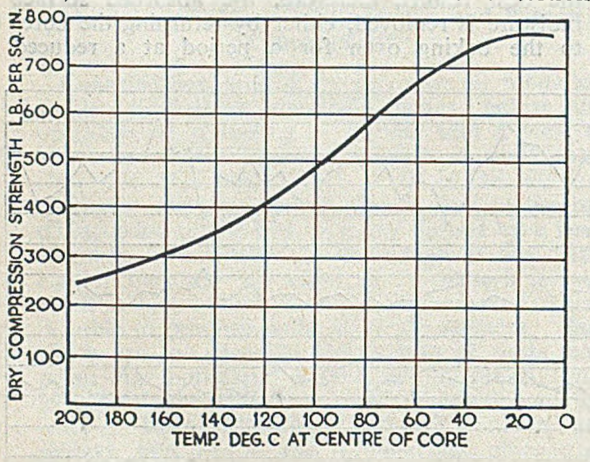


FIG. 6.—*Determination of Baked Strength of Oil-sand on Cooling from Baking to Room Temperature; Baking Temperature, 200 deg. C. for 2 hrs.*

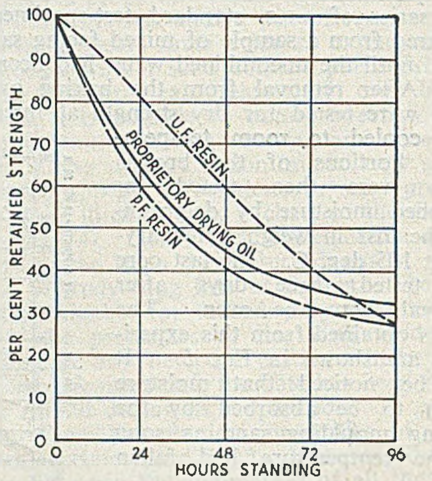


FIG. 7.—*Effect of Storage on the Dry-strength of Oil- and Resin-bonded Sands. Oil Mixture was: Oil 1.75, Cereal 0.80, and Moisture 4 per cent., Baked for 2 hrs. at 210 deg. C. Resin Mixtures were: Resin (net) 0.75, Cereal 1.5, and Moisture 4 per cent., Baked for 1 hr. at 190 deg. C.*

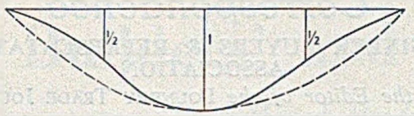


FIG. 8.—*Mis-shapen Camber resulting from Incorrect Setting of Strickles.*

that the most usual practice was to set the full camber at the correct point, and to use half of the full camber at points half way between the centre of camber and the ends of the bed. This caused the camber to be set in a mis-shapen manner.

Using one strickle the full length of the pattern and assuming no springing back of the strickle occurred, the resulting camber set in the mould was similar to that depicted by the full line in Fig. 8. After consideration of the factors involved in the distortion of long castings of the machine-tool bedplate type, it was realised that the desired camber to be set in the mould should approximate to an arc of a circle (broken line in Fig. 8). The difference between the two curves is quite considerable. A formula was then derived from geometrical principles so that the distribution of camber at any point along the arc of a circle could be calculated, provided that the maximum camber was known. Also, the length of strickles was standardised at 5 ft. and the camber required at points at the junction of these strickles was calculated. A diagram showing the amount and distribution of the required camber is now issued to the moulder before moulding is commenced (Fig. 9).

Setting Camber

For the camber to be set accurately, it is necessary to put the required radius of curvature into the strickle. The amount of curvature required on 5-ft. lengths, however, is very small, and it is within the experimental error to use straight strickles. The discrepancy occurring by this method can be judged from Fig. 10, which shows the camber setting points connected by (*a*) straight lines, and (*b*) arcs of a circle. In order to illustrate the difference more clearly, the error has been magnified approximately 60 times by adjusting the scales of the vertical and horizontal measurements.

The foregoing remarks have assumed that the casting to be produced has a uniform cross-section along its entire length, in which case the centre of

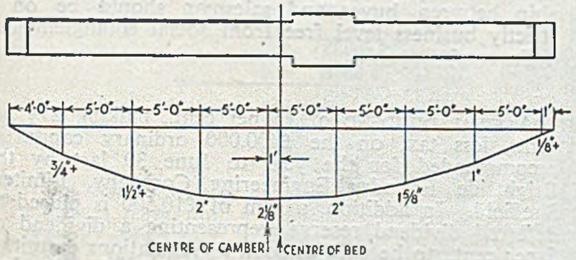


FIG. 9.—*Camber Sheet Issued to Moulder for a Planing Machine Bed. Dimensions: Length, 36 ft. plus Sumps; Depth, 2 ft. 2 in.; Width, 3 ft. (Cheeks).*

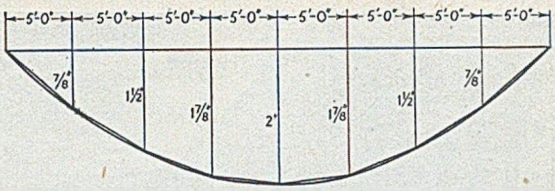


FIG. 10.—*Illustrating the Negligible Error caused by using Straight Strickles in Setting Chamber.*

camber, *i.e.*, the point at which the maximum camber occurs, is at the centre of the casting. Bedplates for planing machines, however, possess heavy flanges of metal projecting from the sides, on to which the cheeks for the crossrail are bolted. From Fig. 9 it will be seen that these projections are not in the centre of the bed, in fact they may be anywhere along the bed, depending upon the design of the machine.

Isolated heavy metal-sections affect the resulting distortion of a casting since in addition to altering the cooling rate, they possess additional strength and so prevent the casting from bending. Accordingly, the end of a bed casting containing the heavy side flanges cambers less than the uniform end. This difference in cambering tendencies is allowed for by moving the centre of camber from the centre of the casting to a point away from the projections. The actual location of the centre of the camber is determined from past experience in the production of similar castings. The net effect of altering the centre of camber is to increase the curvature of the end to which the camber is moved,

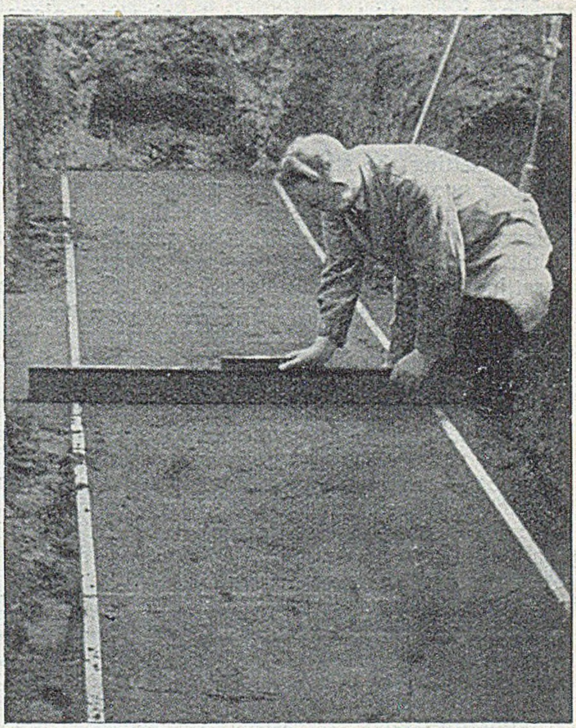


FIG. 11.—*Checking Camber in the Bed for a Large Mould.*

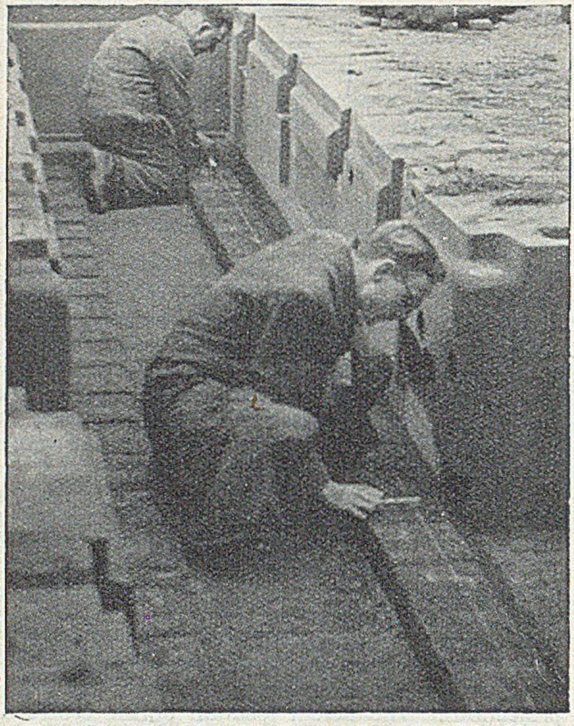


FIG. 12.—*Checking Camber in the Same Mould as Fig. 11 after Setting the Chills for the Slideways.*

and simultaneously decrease the curvature of the other end.

Castings which possess no longitudinal plane of symmetry require side camber to be used when setting the pattern, in addition to the usual bottom camber, in order to nullify the distortion produced by the differing cooling rates of the two sides of the casting.

In setting the strickles, a string is first stretched along one side of the floor of the casting pit from two points at equal depth below the foundry floor-level. The strickles are then placed underneath the string to give the desired camber by using setting blocks of the required size. Great care is taken when securing the strickles in the floor of the pit to ensure that no movement occurs. Before the string is removed, the camber points are checked by the laboratory staff. The whole process is then repeated at the other side of the pit so that two lines of strickles, accurately set, are secured in the floor. Facing sand is then firmly rammed in between the two lines and the surplus sand strickled off. During the strickling-off process, the accuracy of the strickle setting is checked by placing a spirit level across the junction of the strickles at each end of the mould (Fig. 11).

The camber is again checked after the mould has been dried, and the chills forming the slideways have been placed in position (Fig. 12). In this way, the number of defective castings produced through incorrect camber has been reduced to a minimum, and a casting rejected because of excessive distortion has become a rarity.

(*To be continued*)

Correspondence

ENGINEER BUYERS & REPRESENTATIVES ASSOCIATION

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—Whilst thanking you on behalf of the Council for the editorial mention of the Engineer Buyers & Representatives Association in the September 6 issue of your excellent journal, I have to convey to you the protests and dissent of many of our members at the following editorial comment:—"It is debatable whether there is any need for such an association, as other bodies cater for the purchaser and separate ones for the commercial traveller."

In these days of an ever-widening field of engineering, which enforces more and more specialisation, this is a surprising point of view, more especially when it is put forward by the Editor of a trade journal which —outstanding and necessary though it undoubtedly is— is only one of a hundred or more other publications serving the engineering trade and industry!

The Engineer Buyers & Representatives Association—probably the only professional body operating exclusively on the commercial side of engineering—came into existence because in fact *there were no other professional bodies with membership restricted to qualified engineer buyers or engineer representatives.*

Those in the latter categories, many of whom have high technical qualifications and substantial incomes, had long felt that there was an urgent need for a professional association exclusively to serve their interests, bring them in touch one with another, disseminate knowledge and information and to establish and uphold a status well above that of the average commercial traveller or of the personnel of so many of the buying departments of industry and commerce.

That the E.B.R.A. is performing these functions is proven by the fact that nearly five-hundred qualified engineer buyers and engineer representatives have already sought and obtained membership.—Yours, etc.,

ARTHUR J. DRONSFIELD,
General Secretary.

P.S.—Membership has increased by some 20 per cent. since the E.B.R.A. Guide & List of Members went to press

Engineer Buyers & Representatives Association,
47, Victoria Street, London, S.W.1.

[We are still not convinced, for after all there is a Purchasing Officers' Association for buyers and the well-known United Kingdom Commercial Travellers' Benefit Society for salesmen. Moreover, if salesmen are qualified engineers then they have the privilege of participating in the activities of the bodies which have recognised their proficiency by the awarding of a certificate or diploma. Is it not preferable that relationship between buyer and salesman should be on a strictly business level free from social entanglements? —EDITOR.]

A FINAL DIVIDEND of 15 per cent., making 27½ per cent., less tax, on the £400,000 ordinary capital is recommended for the year to June 30 last by the Brightside Foundry Engineering Company, Limited, Sheffield. In addition, a sum of £10,500 is placed to deferred dividend reserve, representing a dividend of 5 per cent., to be paid as soon as regulations permit.

For the previous year a total of 25 per cent., less tax—interim 10 per cent. and final 15 per cent.—plus a tax-free capital distribution of 5 per cent., was made on the present capital, compared with 50 per cent. on £200,000 of capital for 1948-49.

Builders' and Engineering Castings

Mixed Production at Watford Foundry

The importance of Watford as a manufacturing town has increased rapidly in recent years. Because of its proximity to London and its excellent rail and road facilities, this centre has many attractions for industrialists. Particularly convenient is the Watford by-pass to London, along which are now located large and modern factories. In May, 1934, a site of eight acres adjoining this road was acquired by the newly-formed Watford Foundry Company, Limited, whose managing director, Mr. L. H. Crump, was formerly with Welwyn Foundry. The site was agricultural ground when it was taken over, and the foundry was the first building to be erected on the by-pass, so that the company can claim to have been the pioneers of industry in this area. The foundry was established primarily for the production of builders' castings and eventually succeeded in achieving an output of 70 tons melted per day. By 1939 it was supplying a large proportion of the builders' and plumbers' merchants in London and Southern England. When the war came, the foundry was switched to the production of engineering castings for armaments, and many components were supplied to the Government. Though the company still produces housing castings, a large proportion of the melt is now absorbed by engineering castings, which are supplied to many well-known engineering concerns in the South of England. The output comprises castings for earth-moving equipment, bulldozers, agricultural machinery, printing, brewing and textile machinery, aircrafts, machine tools, lifts and elevators, shop fittings, photographic equipment, etc., together with a variety of light- and heavy-engineering castings. A selection from this range is shown in Fig. 1. Production includes both jobbing and repetition work, some of the orders received running into several thousands off. Individual castings produced in the ironfoundry range in weight from a few ounces up to half a ton. There is also a non-ferrous section which supplies castings in aluminium, gunmetal and phosphor-bronze. Production has been partly mechanised by the installation of three cranes, a sand-preparation plant, and both hand-operated and jolt-squeeze moulding machines.

Moulding Shop

An outstanding feature of the foundry is the very large moulding shop shown in Fig. 2, which has an area of 55,000 sq. ft. under a single roof. Of saw-tooth construction, this roof affords excellent lighting throughout the shop, while ventilation is also good. The generous floor space available has facilitated good housekeeping and layout, thus allowing working conditions of a high standard to be maintained. The floor is of concrete throughout and wide gangways, running both lengthwise and across the shop, enable metal or sand to be transported to any point with maximum convenience. Sectionalisation of the various departments has been more effectively achieved than is usually possible in foundries where space is more restricted. Not only are floor and machine moulding segregated in the usual manner, but there is no overlapping between the principal classes of work, each of which has been allocated a well-defined area.

One section is devoted to fall-pipes for houses,

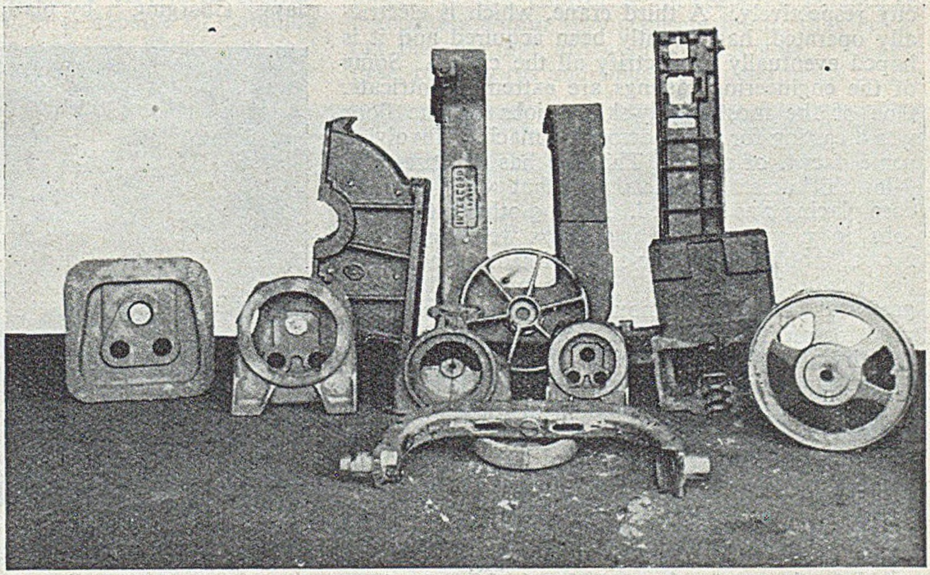


FIG. 1.—*Selection of Castings from the Range Manufactured for Engineering Industries by Watford Foundry Company Ltd.*

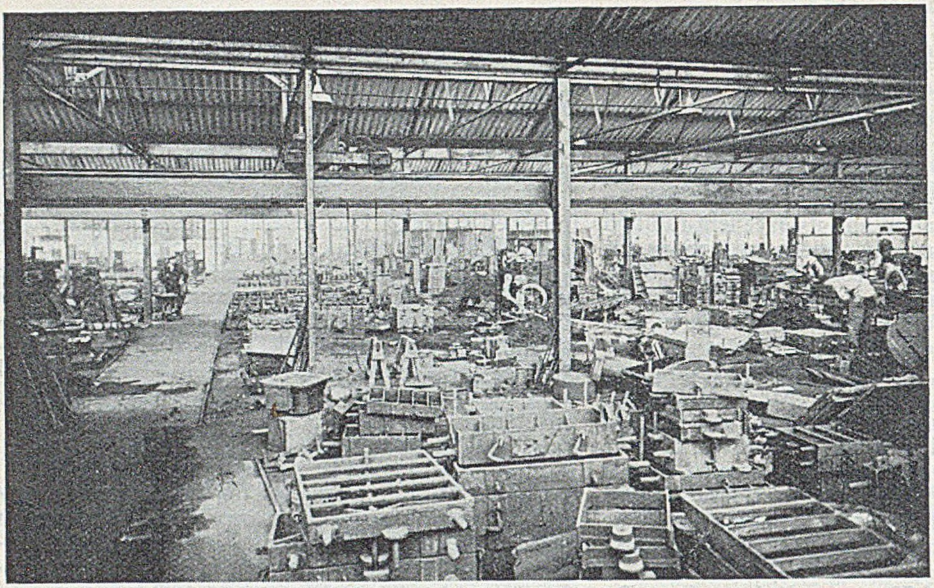


FIG. 2.—*General View of the Moulding Shop at Watford Foundry; Note the Clear, Concrete-covered, Gangway on the Left-hand Side.*

which are cast in green-sand for loose patterns, the cores being made in a cast-iron corebox and bar. Two men are able to produce some 33 moulds per day, doing their own coring up. A separate bay is devoted to gutters, which are plate-moulded, two in a box. The various machine-moulding sections are devoted to the production of bends, branches, etc., as well as light-engineering castings. One man makes the drags and copes, cores up and closes the boxes, this principle of a single moulder carrying out all stages of each job being adopted for all machine-moulded castings. There is a small output of certain builders' castings from loose patterns, this type of work being confined to odd sizes or castings which are too big for the machines. The jobbing engineering bay is covered by two hand-operated overhead cranes of 3-ton and 2-ton capacity respectively. A third crane, which is electrically operated, has recently been acquired and it is hoped eventually to electrify all the cranes. Some of the engineering castings are extremely intricate. One of the most highly-skilled jobs on the floor was a casting for a woodworking machine involving some 4 cwt. of metal. This job has 18 cores and $\frac{3}{8}$-in. thicknesses of metal, so that very accurate core-placing was required. Among other interesting jobs in progress were a gearbox weighing about 2 cwt., moulded in green-sand with dry-sand cores, and a table for a vertical grinder produced from a green-sand, skin-dried mould. Dry-sand was being used for much of the larger work, such as a jig for the aircraft industry weighing 8 cwt.

The sands used are Mansfield red rock sand and Leighton Buzzard silica sand, with the addition of coal-dust for facing sands. The sand returned from the moulding shop is transported by barrow to the conditioning plant, where it is loaded on to a conveyor. After travelling over a vibratory sieve and a magnetic head, it drops into the mill. The conditioned sand is discharged on to a conveyor and elevated to the roof, where a plough feeds it either into a Sandslinger of large capacity or into a bin at floor level, from which it is distributed by barrow to the moulders.

Separate core-shops are provided for large and small work. The equipment of the small core-shop includes a "Spermotor" for the production of standard circular cores, which are turned out at the rate of about 240 ft. per hour. With this exception all cores are hand-produced. An electrically-heated drying stove is provided for the very small work, as well as two coke-fired batch-type ovens for the medium sizes. The larger cores produced in the other shop are also dried in coke-fired stoves.

Melting Plant

The melting plant comprises two cupolas each of 10 tons per hour capacity, operated on alternate days. Charging is by platform lift using only pig-

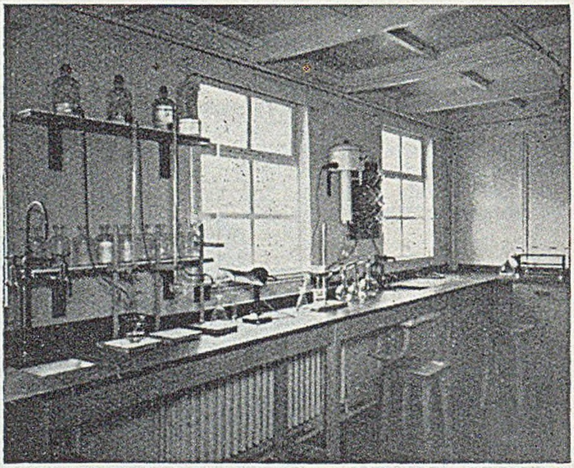


FIG. 3.—*Part of the Newly-installed Foundry Control Laboratory. At present only Iron-foundry Materials are Handled.*

iron, shop returns and purchased machine scrap of best quality. Any additions to the ladle are made by a metallurgist, the melts being under laboratory control; part of the laboratory is shown in Fig. 3. Casting begins about 3 p.m. and continues throughout the afternoon. Bogie ladles of $\frac{1}{2}$-ton capacity are used for metal distribution. For pouring, the moulders are divided into squads of three or four, each team being responsible for one bogie.

In the non-ferrous foundry, the melting plant includes two oil-fired furnaces, three pit furnaces, and one coke-fired furnace. Typical of the non-ferrous production are aluminium drip-trays, aluminium machine guards, and gunmetal flange pipes, as well as the company's own requirements of aluminium patterns for plate and loose-pattern work. Normally the castings produced in this section range in weight from about 4 oz. to 1 cwt., but a job weighing $1\frac{1}{2}$ cwt. was recently cast in aluminium. This was a large strap for a machine and presented no difficulties. The dimensions of the largest box in the non-ferrous shop are $10\frac{1}{2}$ ft. by 18 in. by 12 in.

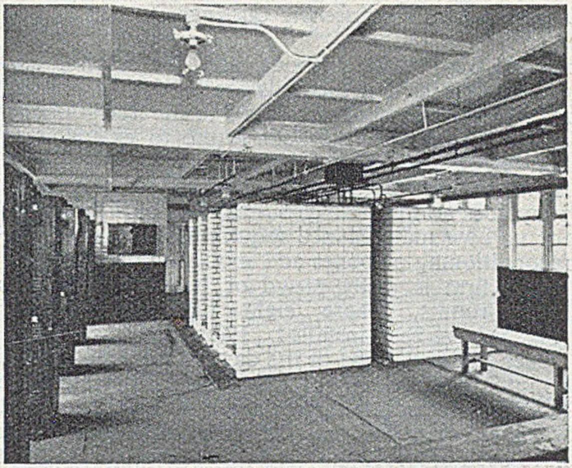


FIG. 5.—*Shower-bath and Changing Room Installed for Foundry Workers. Clothes Lockers are on the Left-hand Side.*

Fettling Shop

The fettling shop is equipped with both electric flexible shaft and pneumatic grinders and pneumatic hammers. Three shot-blasting plants have been installed, one being of the barrel type, another of the table type, and the third a cabinet for the larger work. Pipes and small castings are fettled in a separate shop, which is equipped with six floor-grinders and a battery of rumblers for pipes and fittings. After fettling, pipes and other builders' castings are passed through an oven, are elevated, and dipped into a tank of Dr. Angus Smith's solution. Throughout this process they are transported by an overhead runway, the smaller jobs being handled in baskets and the larger ones on carriers.*

The establishment includes a very large central-heated pattern-shop, which is capable of handling all types of patterns in wood or aluminium (see Fig. 4). Fluorescent lighting is installed over the benches and each bench is provided with a small air-operated drill. The shop is equipped with a planer, one large and two small bandsaws, a circular saw, disc sander, drilling machines, and both medium- and large-size turning lathes. There are two pattern-stores, one of which is reserved for large patterns. The principle adopted in the smaller store is to have the heavier patterns on the floor and the lighter ones on top, plated patterns being kept at one end and loose patterns for builders' castings at the other.

An analytical laboratory (Fig. 3) is one of the most recent acquisitions and is fully equipped for the usual analyses for carbon, phosphorus, silicon, manganese and sulphur. One of the principal objects of this control is to keep the balance of manganese within very accurate limits, thus ensuring that castings are easily machinable. Manganese, phosphorus and silicon are determined by the

* This section was fully described in the JOURNAL for May 19, 1938, p. 399.

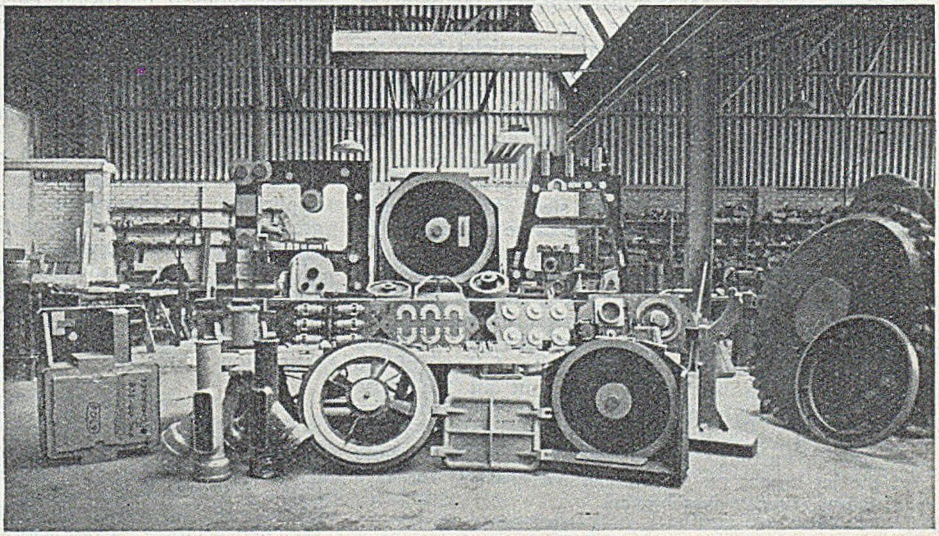


FIG. 4.—*Group of Patterns of the Types in Regular Use at Watford. Note the Wide Variation of Size Range.*

Builders' and Engineering Castings

normal qualitative methods, and for sulphur and carbon combustion methods are used. At present, metallurgical control is confined to the iron foundry, but it is hoped in the near future to extend it to non-ferrous metals. A metallographic laboratory is still in the process of being equipped. The company does no machining, but has a small fitting shop for its own maintenance requirements, such as the reconditioning of boxes and moulding machines.

The firm is justly proud of its very up-to-date change-rooms, where eight tiled shower-baths (Fig. 5) have been installed. Each man has his own locker and at the end of the day his working clothes go into an electrically-heated room for drying; these facilities are greatly appreciated. Despite the good working conditions and the many amenities which have been provided, however, new labour, as in most areas, is difficult to obtain for the foundry.

Jet Tapping of Furnaces

Use of the oxygen lance for opening the tap-hole of an open-hearth furnace has its drawbacks and risks, according to H. H. NORTHRUP, superintendent, open-hearth department, Republic Steel Corporation, Buffalo, N.Y.* The hole burned through the thick crust of the tap-hole facing, he contends, may be so small that the flow of metal will freeze in the stopper-well in the bottom of the ladle, resulting in teeming troubles. Early in 1947, Dr. B. S. Old conceived the idea of using a shaped explosive charge generally similar to that used in the war-head of the bazooka, but suitably modified for the intended use and effectively protected against damage or premature detonation by heat of the tap-hole. This led to the development of the jet tapper, which consists of a 2-oz. explosive charge enclosed in a plastic case. In the back of the case is a well for the blasting cap, while the key to the penetrating power lies in the thin copper cone which is embedded in the front of the case. The entire case is covered by a bullet-shaped insulating shell ½ in. thick. The charge is relatively less sensitive to impact or friction than most commercial explosives, and will not detonate, but only burn if heated to a sufficiently-high temperature. The explosive of the jet tapper, when detonated, creates a high-velocity jet of minute copper particles from the cone, with velocities of individual particles ranging from 10,000 to 30,000 ft. per sec., the enormous energy built up causing the metallic crust to flow, like liquid, away from the path of the jet. The diameter of the hole produced depends on the temperature of the crust, but tests have shown the jet tapper to produce a hole approximately ¾-in. dia. in cold steel, while in steel heated to 820 deg. C. approx., the same charge would produce a hole 1-in. dia.

The jet tapper is now used on all heats tapped at the Buffalo, N.Y. and Warren, Ohio, plants of Republic Steel Corporation, with approximately 85 per cent. of them bringing success. Failure of charges to effect a good tap can usually be traced to failure of the second helper to thoroughly rake out all the loose material in the tap-hole or to a short tap-hole caused by an abnormal penetration of metal and slag. Experience has shown that with a properly-raked-out tap-hole and the jet tapper resting against the crust of the tap-hoel facing, success is achieved.

* Report printed in *Iron and Steel Engineer.*

Mechanical Engineering Research

Progress at East Kilbride

During many years, research into mechanical engineering problems was conducted at the National Physical Laboratory. Facilities there, however, became too restricted to allow full use of heavy testing equipment, and in 1946, preliminary to the transfer of this important work to more commodious premises, the Mechanical Engineering Research Board was appointed and held its first meeting in May, 1947, headquarters being set up in London. Since then, however, the Board has moved to East Kilbride in Scotland, where, as is now generally known, the building of extensive workshops and laboratories is in progress. The First Report of the Board, "Mechanical Engineering Research, 1947-50" (H.M. Stationery Office, price 2s. 9d. by post), gave details of the origin of the research station, the scope of its work and the progress achieved to that date.

Much of the work up to now has continued at the N.P.L. while some of it has been done at temporary premises near East Kilbride. Since the Report was prepared, however, the first buildings, including the workshop, boiler house and the main part of the "Properties of Materials" laboratory have been completed. In order that the most rapid progress can be made with research, this laboratory will be used at first as a general purposes building available for experimental work on materials, mechanics of solids, fluid-flow, heat transfer and mechanics of formation.

Chemical Research Laboratory

The annual series of "Open Days" at the Chemical Research Laboratory at Teddington was held recently for the fifth consecutive year, at which an opportunity was given for staff of Government departments, universities, and industrial firms to view a number of interesting exhibits and to acquaint themselves with the programmes of research which are now in progress. Very little was exhibited which was not seen last year. The corrosion of metals group has a large programme in hand and study in a number of particular fields has been continued during the year. These include the effect of high-speed movements on corrosion rates of mild steel, the influence of temperature, passivation, microbiological corrosion, effect of pressure on corrosion rate, effect of inhibitors such as sodium benzoate and sodium salts of carboxylic acids. Further work on accelerated corrosion testing is in progress, and a programme of work has been devised to determine the effect of mass, and therefore heat capacity, on the rate of corrosion of specimens in sheltered "outdoor" conditions. Much of the work on ore treatment carried out within the "Radiochemical" group which has some application to industry was still on the secret list. The greater part of the work of this group is carried out on behalf of the Division of Atomic Energy of the Ministry of Supply and is concerned with the analysis and treatment of radioactive ores. Exhibits of this group were therefore of general interest and included methods of analysis, chromatographic methods of separation and estimation of metals.

AT THE FIRST MEETING of the Institute of Fuel for the 1951-52 session, which will be held at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1, on October 16, Prof. F. H. Garner, Melchett medallist for 1951, will deliver the Melchett lecture, "Combustion Processes in Engines."

Symposium on Enamelling of Cast Iron

The whole of the afternoon session of the Spring Conference of the Institute of Vitreous Enamellers at Bournemouth was devoted to a symposium on the enamelling of cast iron with Dr. J. E. Hurst, J.P., president, in the Chair. Various aspects of the subject were introduced by Mr. C. P. Stone of Ferramic Industries Limited, Mr. K. E. Walker of English Electric Company Limited, Mr. F. H. Hoult and Mr. W. J. Colton of Newton, Chambers & Company, Limited, and Dr. Hurst representing Bradley & Foster Limited and Staveley Iron & Chemical Company Limited. The following are abstracts from the papers and the discussion which ensued:—

NECESSITY FOR CO-OPERATION

Mr. C. P. Stone in the course of his opening remarks said:—

In view of the widespread use of cast iron today for domestic equipment, and the acid-resistant finish which is demanded by the authorities, with the added difficulty of white and pastel colours being popular, it is becoming increasingly important that the enameller and the foundry co-operate in a full measure. By being aware of each others' difficulties, a standard of quality can be established in the production of castings, which must be " free " from blowholes, dirty gates and burnt-in sand, thus affecting the cost of the finished article in a major degree by reducing rejections in processing. Since 1934, the Institute of Vitreous Enamellers has presented a number of papers by well-known technicians, but on the whole the Author is of the opinion, that due to lack of co-operation between the foundry and the enameller, neither has done very much about it. Each has continued to blame the other for the results obtained, rather than tackle them jointly in the interests of the industry.

It is important that daily meetings, and examination of the results obtained in the enamelling, should take place between the foundry and the enamelling department. Where this does happen, is on plants where the highest percentage of good work in one coat direct to metal is obtained.

A few of the papers which can be found in the I.V.E. Proceedings, which should adorn every enameller's bookshelf, are:—" Common Defects," (1936); " Cast Iron for Vitreous Enamelling," (1936); " Acid-Resisting Enamelling of Cast Iron," (1936); "Analysis of Cast Iron suitable for Vitreous Enamelling," (1937); " Moulding sands and facings," (1939); " Foundry and Enamel Practice applied to Cast Iron," (1939); and a number of others of more recent years.

After many years of experience the Author recommends that the foundry can make all the difference to the results obtained in the enamelling shop, if the matter is approached without prejudice, or the production of castings at a price, rather than the cost of the finished enamelled casting. It is not sufficient for the castings to be supplied to the enameller in the ordinary way of foundry production.

Standard of Castings

After dressing, castings should be blasted in the foundry and close inspection made to see that they are free from blowholes and dirty gates, and the facing sand used should be one that will not burn into the metal. The reason for blasting is obvious, as it discloses many defects that are not seen when the castings are taken from the sand. Stopping, however, if properly rammed in, can fill some holes. Large ones should be pinned with a cast-iron taper pin, which exactly fits a hole drilled by a taper drill. This is peened over from the back with a hammer, and takes less than a minute per hole to accomplish. Only cast-iron pins are satisfactory, and on no account should steel be used.

Experience has shown that where co-operation exists, strict attention is paid to the refractory facing sand, which should be particularly strong in bond and used in ample quantity. It has also been found that plenty of space for the gate should be allowed, to prevent the slag or dirt being in the casting when it should be in the runner. This ample space for the gate necessitates the use of a larger moulding box, which costs more to make, but in the end is more economical, as a higher percentage of good enamelling castings are produced. The reason for this statement is based on the Author's original experiments prior to 1935, when he introduced acid-resisting vitreous enamel on cast iron. Success was only made possible by the active support and co-operation of the foundry, which produced castings which were free from blowholes and burnt-in sand. This was particularly important in those days, when the enamels used were not so suitable as those in operation today. Widespread experience on many plants has since only confirmed the importance of co-operation between the foundry and the enameller, to obtain the best results at an economical price.

Castings Tests

Castings made by any method, however, can give varying results unless daily tests are taken of each day's work, which should be date-stamped on the day made, and enamelled and passed by as being reasonably correct for processing inspection on the same day. In the event of failure, the test should be repeated, and if still bad, the castings should be retained for closer examination.

It is understood that some companies produce castings that yield a very high percentage of good work in acid-resisting enamel applied direct, whilst others produce a good-looking casting which enamels badly. There must be a reason for this, and it is hoped that an investigation of the methods used by various manufacturers of castings will be made possible, as the information obtained could be an advantage to all concerned if freely circulated.

It is important that castings be enamelled by

Symposium on Enamelling of Cast Iron

direct application without the use of ground coat or grip coat, and consistent results obtained in the enamelling process, in order that the enameller can proceed with his job of enamelling to a programme, which can march with the continuous assembly that is generally employed today. It has been accepted for many years that all castings should be annealed, and generally this is true, but there are castings being produced today in large quantities, which when annealed produce blisters wholesale, and which appear perfectly sound if not annealed.

The question the industry generally would like an answer to is: "What happens to a casting when it is heat-treated at the annealing temperature of approximately 800 deg. C.?" Explanations from various well-known technicians vary so much they can be of little value as a solution to the problem. This should be the subject of investigation, because if annealing could be abolished in itself it would be a great economy, provided always that oil and grease are kept away from the casting when drilling or tapping.

Enamels have improved considerably in recent years in every way, particularly in workability, resistance and colour, but it is thought that the idea still exists in the foundryman's mind that enamel will run into a hole or bridge a gap, and unfortunately this is not true. Considerable argument is anticipated on this point, which will be welcomed, as out of this discussion much will be learned by the foundryman and the enameller.

Conclusion

In conclusion, it is suggested that a committee should conduct investigation into several sections, with the idea of co-ordinating all the facts into a common recommendation to the combined industries, as follows:—

(1) Design; (2) foundry sand, and in particular facing sand or any method of manufacture which will prevent moulds breaking and consequent blowholes in the casting, sand burning-in and dirty gates; (3) an investigation as to what happens to the surface of a casting during heat-treatment in an enamelling shop, which affects the enamel finish of certain castings; (4) vitreous enamel processing of cast iron, with particular attention to the drying of the coatings of enamel, and the effect that humidity in the drier can have on the results obtained.

FOUNDRYMAN ENAMELLER'S VIEWPOINT

Mr. K. E. Walker then gave his Paper, speaking as an analytical chemist turned foundryman and vitreous enameller, and claiming an unbiased viewpoint:—

Having spent six years producing electric-cooker components, the Author would allocate 60 per cent. of the responsibility for the various troubles to the foundry and 40 per cent. to the enamelling shop. Cast iron itself is quite a complex material frequently containing undesirable impurities in excess, and it is true to say that no two cupola tappings are quite alike. Enamels are even more complex and mysterious and oxides are frequently used which alone contain about 16 elements, some of which are amphoteric.

The manufacturers of vitreous enamels have rather "put the cart before the horse." They have developed colours and frits by trial and error and now the unhappy users of these materials are trying to fathom their chemistry. To make matters more unfortunate in the case of acid-resisting enamel, this unpredictable mixture has to be fused at the very critical temperature of 760 deg. C. It is not surprising, therefore, that the Americans have practically abandoned the process in disgust whilst we in this country are still making such "heavy going."

Blistering

One of the main problems facing vitreous enamellers of cast iron is still that of general blistering. All other problems are more tangible and in fact most of them can be dealt with under the heading "Shop Supervision" and will normally respond to commonsense treatment.

Referring to Mr. Stone's comments earlier about the plugging and filling of castings, the Author interrupted his Paper to say that he has for the last four or five years been welding small holes quite successfully, using oxy-acetylene and soft iron electrodes. If properly carried out, these welds showed no tendency to blister. Also, mild steel screws were used to plug small holes, and no difficulty was experienced in enamelling over them.

Returning to the subject of blistering, the Author continued:—There is little evidence that this problem has been solved anywhere in the industry. In the first instance it is no longer generally believed that the composition of the iron is of any great importance, provided, of course, that it casts "grey" and is free from alloys such as chromium.

Neither does the Author subscribe to the general view that the face of the casting to be enamelled should be in the bottom half of the moulding box. If slag and loose sand are successfully eliminated it is preferable, from a foundry point of view, to have the enamelled face of the casting in the top of the mould. The metal then rises up to the important mould face instead of running over it. It is thought that the main cause of general blistering is some form of surface contamination (or condition) reacting with the enamel. It has been established on many occasions that new castings can be enamelled successfully without annealing and in certain cases annealing does more harm than good unless it is carried out to an almost absurd extent. This belief seems to have been confirmed by Mr. Stone's own observations. It has also been proved that castings which are not knocked-out quickly, but are left in the moulds or left with sand on them for several hours, are very much more prone to blister, particularly in damp weather.

The type of general blistering which is so prevalent can usually be cured by:—

(1) Weathering the castings for periods between three to six months (the castings tend to "pit" and corrode after six months); (2) surface grinding;

(3) prolonged shotblasting; (4) prolonged annealing; (5) re-enamelling the casting and so making use of the fluxing action of the first coat of enamel.

It will be noted that all these operations remove the casting surface either mechanically or chemically, but none is really satisfactory for a production job. The weathering takes time and involves extra cleaning, surface grinding will not reach the whole of the casting, the shotblasting and extra annealing are uneconomical, and no comment is required on the re-enamelling.

Surface Contamination

Work is still proceeding to investigate the nature of this surface condition. At one time it was thought that it was caused by parting powders, next that it was rust spotting, then that it was some contamination from coal-dust ash. One very significant clue, which has been found, however, and which has since been reported upon in a recent German Paper (V. L. Vielhaber Ber. Deut. Keram. Ges., 1950, 27 (1-2, 42-47 (Appendix I)), is the presence of a heavy surface concentration of sulphur on castings which have been prone to blister. In some instances concentrations of sulphur on the surface have been found amounting to as much as 0.35 per cent., which have been reduced to normal figures by weathering and annealing.

The evidence appears to suggest that not only is the use of a facing sand necessary, but also that this sand should be composed of at least 50 per cent. of new sand. It is found that the sulphur content of the sand increases appreciably with repeated use, and that the sulphur pick-up on the skin of the casting is from the mould face itself. The sulphur content of the sand forming the face of the mould should be less than 0.03 per cent. It may be interesting to note at this stage that blistering is more pronounced with synthetic sands than with naturally-bonded sands, possibly because the high iron-oxide content of the naturally-bonded sands will largely prevent the pick-up of sulphur in the skin of the casting. Intensive work should be carried out to establish the nature of this surface contamination and it is most significant that annealing will actually aggravate the condition. There have been many examples of castings blistering rather badly in the unannealed condition, blistering really violently after being annealed at 800 deg. C. for 30 min. and being completely free from blistering after having been annealed for 800 deg. C. for 90 min.

The facts suggest that the presence of free cementite due to high sulphur in the skin of the casting is not detrimental when the casting is new and is enamelled without annealing. Normal annealing apparently only partially breaks down the skin and leaves it in a much more reactive condition than on the original casting. Prolonged annealing may well complete the process and destroy the harmful effect of the skin. If the casting stands for long periods in a warm humid atmosphere, it may be possible that weak mineral acids are formed which penetrate into the sub-skin and set up corrosion along the graphite flakes, or on the grain boundaries.

Investigation work is being carried out in various parts of the country using wood-flour instead of coal-dust in moulding sand. Other alternate materials are being tested which assist in obtaining a good casting skin without causing surface contamination. It is therefore important to investigate the effect that surface concentrations of sulphur have upon vitreous enamelling results. In many cases it can only be detected by literally scraping the surface of the casting and then analysing those scrapings.

Appendix I—Summary of the Investigations into the Cause of Porosity in Cast-iron Enamels

By V. L. Vielhaber, Ber. Deut. Keram; Ges., 1950, 27 (1-2), 42-47.

It was noticed during investigations into enamelling properties of cast iron that the test-pieces enamelled without blistering on all areas where the skin of the casting had been removed by mechanical means, such as drilling and surface grinding. This was attributed to the presence of sulphides or sulphur compounds in the skin of the casting. The investigation leads to the supposition that the sulphur is obtained from an outside source and is transferred from the mould to the casting surface. In order to investigate this supposition, tests were carried out on castings made:—(1) In old sand in general use; (2) in new sand with no coal-dust additions; (3) in new sand with coal-dust additions.

It was found that the formation of pores, rust specks, blistering and the peeling of the whole surface can be minimised by ensuring that moulding sand is not allowed to become too old, *i.e.*, that each day a measured quantity of fresh sand is added. In use the sand is enriched in sulphur, and by adding new sand, this is again reduced. It is shown in the report that with a sulphur content in the sand of under 0.029 per cent., no blisters were formed, but over 0.029 per cent. sulphur blistering occurred. Attention is drawn to the fact that Dr. Königer pointed out in 1949 that the sulphur content of the surface of the cast rises, the longer the casting is left in the mould (in contact with the moulding sand).

The investigation points to the fact that great attention must be paid to the moulding sand if iron suitable for enamelling is to be cast, and concludes that, without doubt, enamelling faults are brought about by old sand, and general practice in numerous foundries has shown that these faults can be minimised by a daily liberal addition of new sand.

GASES IN IRON AND STEEL

By Dr. J. E. Hurst (President)

Dr. J. E. Hurst began his contribution to the Symposium by saying:—

The vitreous enameller recognises defects in the enamelling process which may be attributable directly or indirectly to the influence of gases evolved from the metal during firing. It is the purpose of the report which follows to consider the known facts concerning the nature of the gases in ferrous materials and to point out the differences which have been observed as and between cast iron on the one hand and steel on the other.

Symposium on Enamelling of Cast Iron

Theoretically and experimentally it may be shown that the gases oxygen, hydrogen, nitrogen, etc., in the molecular form[1], do not dissolve in and diffuse through solid iron or steel. Solution of these gases is preceded by dissociation to the atomic state. Similarly, compound molecules such as carbon dioxide, carbon monoxide, sulphur dioxide, etc., must also dissociate before these gases or their derivatives can penetrate into the iron lattice. Steel or iron will take up hydrogen readily on immersion in dilute acid during the pickling process. The hydrogen is then, of course, in nascent or atomic form. Under these circumstances the metal becomes supersaturated with hydrogen and on subsequent exposure to the air over a period of time the gas slowly diffuses to the surface where it escapes to the atmosphere as molecular hydrogen.

Another way of introducing gas into a ferrous metal is to melt the metal in the gaseous atmosphere. The solubility of most gases in molten iron and steel increases with temperature, following the general behaviour of solutes and solvents. Ample opportunity is provided during the melting of iron and steel for the taking up of various gases. The ambient furnace atmosphere usually contains abundant sources of supply of nitrogen, oxygen and hydrogen from the combustion air or from the fuel. Furthermore, at melting temperatures these gases are partially dissociated in contact with the molten metal. The solubility of gases in molten metals at constant temperature varies as the square root of the summation of the partial pressures of all the gases present:—

$$\text{Solubility} = K\sqrt{P_1 + P_2 + P_3 + \ldots + Pn}$$

Thus the solubility of one gas can be reduced by dilution with another. This action takes place during the " boil " period in steelmaking when carbon monoxide is evolved in large quantities, sweeping out the hydrogen dissolved during an earlier stage in the melt down. The final gas content in liquid steel may also be modified during the refining process by making additions of reactive elements which " fix " the gas in the form of solid or liquid compounds which either float out of the melt or remain as inclusions more or less dispersed in the solid steel. In this way, the addition of a deoxidant like ferro-silicon lowers the free oxygen content of steel. The gas remaining in the solid ingot of steel or in the iron casting depends upon the algebraic sum of the aforementioned charging and discharging processes and upon the amount of gas thrown out of solution upon solidification. All the commonly-occurring gases are far more soluble in the liquid metal than in the solid. Given the opportunity, the liquid steel or iron tends to find equilibrium in the solid form by ejecting the surplus dissolved gas. This process can seldom be accomplished before the metal casting or ingot has completely solidified. Thus it usually happens that solid steel and cast iron is supersaturated in respect of its gas content.

In the solid steel or iron there are four main conditions in which the gas can remain:—(1) Adsorbed on the free surface or upon the surfaces of inner cracks, fissures or dislocations; (2) dissolved in one or more of the main phases; (3) chemically combined in non-metallic inclusions; (4) free, as molecular gas in blowholes or cavities.

The distribution of the gases in the metal clearly is influenced by the extent to which it exists under each of the above headings. In a steel ingot or iron casting some of the gas will be present in cavities but in a rolled-steel plate these cavities are not present and thus it might be expected that the gases present in steel plate will be differently distributed from those in iron castings, and perhaps also may differ in amount. Similarly, since steel is known to contain non-metallic inclusions which cast iron apparently does not, then again the distribution of the gases will be different on this account. Cast iron, however, contains graphite which might reasonably be expected to exert an influence upon the distribution of the gases.

Quantitative Data on Gases in Iron and Steel

The systematic study of the occurrence of gases in steel was undertaken in 1937 as part of the work of the Hetrogeniety of Steel Ingots Sub-committee of the Iron and Steel Institute. No systematic study was made of the gas content of cast iron until 1942, when this research was taken up by the research department of Bradley & Foster Limited, Darlaston. This work is now continued in the research department of the Staveley Iron and Chemical Company, Limited, Chesterfield. There is, at present, only one method by which a quantitative result can be obtained for the gases content of metals—this is by the well-known vacuum-fusion analysis. Briefly, a solid specimen is melted in a vacuum apparatus in a graphite crucible whereby the gases it contains are pumped off, collected and analysed. The main constituents of the gas evolved from both iron and steel in this apparatus are carbon monoxide, nitrogen and hydrogen.

A number of pig-irons when analysed in the Author's laboratory[2] were found to have total gas contents varying from 129 ml. at N.T.P. per 100 gm. of iron down to 6 ml. per 100 gm. The hydrogen ranged from 15 to 1.0 part per million, oxygen (as carbon monoxide) from 810 to 10 parts per million and nitrogen 60 to 10 parts per million. In some ancient irons which have been examined from time to time, quite large amounts of these three gases have been found, which suggests that over a period of time there is little tendency for cast iron to lose gases even though it would appear from theoretical considerations to be supersaturated in this respect.

Available data on the residual gas content of steel indicate that marked differences occur, dependent upon the method of manufacture and the mechanical working and thermal treatment it has received. Acid steel averages 4 to 6 parts per million of hydrogen, while basic steels, both open-hearth and electric, averages 6 to 9 parts.[3] After hot rolling and normalising, the steel loses hydrogen and a typical basic-open-hearth boiler-plate gave 120 parts per million oxygen, 35 of nitrogen and 0.3 of hydrogen.[4] Another steel, with 3.5 parts per million of hydrogen in the ingot, contained 1.2 parts as a

2-in. hot-rolled slab and only 0.6 parts as a ½-in. dia. rolled bar.

The gas content of grey-iron castings is of the same order as is found with some types of steel plates. The oxygen content is usually somewhat lower, the nitrogen almost identical and the hydrogen tends to be slightly higher. The variations which have been recorded with both steel and iron are of such a magnitude as to make it impossible to quote " typical " figures without the risk of being misleading in some cases.

An important consideration in assessing the total residual gas content of a fabricated steel structure is the gas content of the weld metal.[6] The range for both electric-arc and gas welding is as follows: Oxygen, 0.050 to 0.500 per cent.; hydrogen, 1.0 to 18.0 ml. per 100 gm.; nitrogen, 0.01 to 0.10 per cent. It is clear that the general level of gas content in the weld is usually in excess of that of the surrounding steel and the gas is obviously present in a highly supersaturated condition.

Escape of Gases

Mild steel, when supersaturated in respect of hydrogen (as for example after pickling or welding), slowly loses hydrogen at room temperature. This can be readily confirmed if a suitably small specimen of steel is confined in an inverted test tube over mercury, when a small hydrogen bubble will develop at the top of the tube. Cast-iron specimens when so treated yield no measurable amount of gas. Because of this and in view of other experimental results[6] it is considered that the residual gases in solid cast iron at room temperature and under atmospheric pressures are not fugitive to the same degree as in steel.

At elevated temperatures, say 500 to 800 deg. C., the diffusion of hydrogen from steel proceeds at a faster rate. Heating steel at 600 deg. C. for two hours *in vacuo* removes all its hydrogen, and at higher temperatures the heating time required diminishes. Cast iron similarly treated behaves somewhat differently; the hydrogen evolution is more tardy and the composition of the gas extracted is different. The gas extracted from steel is almost entirely hydrogen; from cast iron, however, substantial amounts of carbon monoxide and nitrogen are also obtained as shown in Table I.

TABLE I.—*Composition of Gas Samples Extracted from Grey Phosphoric Iron at 800 deg. C.**

Sample.	Total evolved ml. per 100 gm.	Percentage composition of gas.			
		CO_2	CO	H_2	N_2
1	3.2	nil	38.2	58.2	3.6
2	3.1	—	49.0	40.0	11.0
3	2.0	—	33.4	37.6	29.0
4	2.6	—	30.0	50.5	19.5
5	2.1	—	28.7	60.0	11.3

* *Composition of iron used*:—T.C., 3.30; Si., 2.56; Mn., 0.62; S., 0.085; and P., 1.12 per cent.

Furthermore, at any one temperature between 500 and 800 deg. C., the evolution of hydrogen is incomplete. A specimen of iron treated at 500 deg. C. will yield a further quota of gas on further heating at 600 deg. C. and again at 800 deg. C. Steel gives off all its hydrogen at 500 deg. C. (given sufficient time) and so yields no gas at higher temperatures. Results can be seen in Table II.

It is known that the rate of diffusion of hydrogen is slower in highly-alloyed steels than in mild steel and therefore the rate may be expected to be lower in a cast iron. Grey cast iron seems to retain its hydrogen much more firmly than could be explained in this way and there are strong reasons to believe that the graphite in iron is a very important constituent in causing the retention of hydrogen. The graphite may also be responsible for the evolution, on heating, of carbon monoxide and nitrogen in amounts considerably greater than from steel. The difficulty of removing all traces of hydrogen and carbon monoxide from graphite is well-known. After degassing graphite in a vacuum furnace at a given temperature, if the temperature is raised, a further evolution takes place.

Little attention has been accorded to the study of the gas content of malleable iron. It is known, however, that a white cast iron tends to give a more complete evolution of hydrogen at 500 to 800 deg. C. than grey cast iron, although its exact behaviour is complicated, since this same temperature range causes some graphitisation. It might be expected that malleable iron would have a lower residual hydrogen content than unannealed grey cast iron but this has not been proved experimentally.

Conclusions

Commercial forms of steel and cast iron, including malleable iron, all contain in the solid state, hydrogen, oxygen (or carbon monoxide) and nitrogen gases in amounts greater than the equilibrium solubility value. When these ferrous materials are heated to enamelling temperature some of this residual gas content tends to escape from the metal. In the case of steel, the gas evolved is largely hydrogen, and given sufficient time the whole of the hydrogen will escape at temperatures above 500 deg C. With cast iron, not all the hydrogen is removable on heating at 500 deg. C. or above. On the other hand, some carbon monoxide and nitrogen are evolved during the heating. The total amount of gas removable by heat-treatment in this

TABLE II.—*Results of Gas Analysis on Vacuum-heated Samples of Cast Iron.**

Temperature, deg. C.	Time of heating.	Hydrogen.		Oxygen.		Nitrogen.	
		Ml. per 100 gm.	Parts per million.	Per cent.	Parts per million.	Per cent.	Parts per million.
500	2 hr.	0.51	0.4	0.0003	3.0	0.0004	4.0
500	2 hr.	0.38	0.3	0.0002	3.0	0.0004	4.0
600	2 hr.	0.70	0.6	0.0003	3.0	0.0003	3.0
600	2 hr.	0.75	0.7	0.0004	4.0	0.0004	4.0
800	1½ hr.	1.70	1.5	0.0010	10.0	0.0002	2.0
800	1½ hr.	1.83	1.6	0.0014	14.0	0.0001	1.0

* *Composition of samples*:—T.C., 3.30; Si, 2.56; Mn., 0.62; S., 0.085; and P., 1.12 per cent.

way is of the same order as with steel. Weld metal invariably contains an excess of gas and the hydrogen component is evolved fairly readily at enamelling temperatures.

REFERENCES

1 "Diffusion in and through Solids." R. M. Barrer, 1941.

2 "A Study of the Hydrogen, Oxygen and Nitrogen Contents of British Foundry Irons." *Journal of the Iron and Steel Institute*, June, 1948, pp. 130-6, by J. E. Hurst and R. V. Riley.

3 "Gases and Steel." FOUNDRY TRADE JOURNAL, June 8, 1950, pp. 615-22, by Sir A. McCance.

4 "The Third Report of the Oxygen Sub-committee." *The Journal of the Iron and Steel Institute*, No. 1, 1941, p. 314.

5 "The Relation Between the Hydrogen Contents of Weld Metal and its Oxygen Content." *Journal of the Iron and Steel Institute*, 1945, Vol. 2, pp. 385-400, by L. Reeve.

6 "A Study of the Residual Gases in Cast Iron." Proceedings of the Institute of British Foundrymen, Paper No. 899, 1948, by J. E. Hurst and R. V. Riley.

FOUNDRY POINT OF VIEW—MECHANISATION AND SPECIALISATION

By F. H. Hoult

Introducing his contribution and speaking as a foundryman, MR. HOULT said he thought Mr. Stone had forgotten that there was a tremendous amount of very good vitreous enamel castings being produced today.

During the war, the light-castings industry was very much set back. Many of the foundries were completely changed over, and did not have the opportunity for mechanisation. Therefore, the industry as it is today is a new industry, and the problem of supplying castings, on which the rejects are fairly low in enamelling, is one that faces founders generally. The answer to the problems of the industry today can be placed under two headings:—(1) mechanisation, and (2) specialisation. It is the Author's belief that mechanisation and specialisation have got to replace the craftsman, who is not available, and whose shortage will become more and not less acute. Mechanisation consists of cutting out the hard work of the foundry industry; specialisation of cutting out the skill. Casting design is of extreme importance in enamelling.

In the old days, a moulder's pattern may have left much to be desired, but he still managed to produce a good casting. He had no mixing facilities and little chance for sand preparation. Many times he would have to make his own moulding box and decide the size of the equipment required.

When working with a moulding sand and making an impression in the sand into which metal has to be poured, that sand must neither be too hard nor too soft. If the sand is too hard, the metal will "blow" when coming up against a very hard impermeable surface of sand. If it is too soft, the force of the metal will tend to enlarge the shape and penetrate into the sand. These points were not generally realised among enamellers. For instance, difficulty is encountered when trying to hold a core down, because the core tends to float when metal is all round it, and if the core is held down with a nail the remedy might be worse than the original fault. The force of the molten metal in tending to displace sand, whether it be a core or soft-rammed mould, is something which requires much attention; and it must be emphasised that the mould must be rammed evenly.

Pouring

One of the most important things a moulder has to do is to pour the metal or introduce the metal into the casting correctly. The metal must be introduced slowly without turbulence and agitation; the system must be such that the metal will not displace any of the sand; the ideal was that the metal should just run into its position and then solidify.

Nowadays, mechanisation and moulding have to be combined. Ramming is now done by moulding machines, and sand is introduced to the moulding box for jobbing work by Sandslingers. The patternmaker has become the skilled man of the foundry industry, inasmuch as it is he who has to produce patterns which will stand up to the wear and tear of the moulds being continually produced from them, and it is he who, under the direction of the foundry technicians, has to decide the shape and form of runners that are fixed on the plate to allow efficient and controlled pouring.

Casting Face Upward

It has to be decided which way up the casting is to be made. It used to be accepted by the industry that the vitreous-enamelled face must be in the bottom of the mould, but the Author, like Mr. Walker, never puts a face to be vitreous-enamelled in the bottom of a mould. With a controlled runner system and suitably-mixed and treated sand, the flow of metal into the mould can be so controlled that the uppermost face of the casting will give excellent results on enamelling. (Here Mr. Hoult illustrated his points with blackboard drawings and explained how that a better choke effect was obtained.)

It has been found, the Author continued, that, time and time again, when a casting had been cast with its face at the bottom, no matter how good the foundry technique, worse results were obtained than if the face was at the top. In talking about blowholes and dirty ingates and burnt-in sand, these are not faults in a modern mechanised plant.

With regard to Mr. Stone's remark that the only way to make electric-cooker front frames was to hand them to a good moulder and make them on the floor, the Author said that in his foundry anything from twelve to fifteen hundred a week of these items were made on a machine by unskilled labour, and those castings which were quite flat were enamelled in white and pastel shades, and caused no trouble whatsoever. Incidentally, they were made with the vitreous-enamelled face uppermost in the mould.

It has been said that the influence of analysis was a controlling feature on the casting; and that any casting with chromium in it could not be vitreous enamelled. This latter statement has been proved to be false, as the Author's firm actually asked two firms of enamellers if they could enamel a 30 per cent. chromium iron. Although they thought it impossible, both of them did the job, with excellent results. It is the Author's personal conviction that the analysis of the metal is only a factor in the production of good castings. The metal has to be such that the casting will not crack or distort in enamelling, and there must be no porosity causing gasification during enamelling. Beyond that, the limits for satisfactory enamelling are very wide.

Confirmation of Sand Effect

Concluding his Paper, Mr. Hoult said he was surprised and pleased to have Mr. Walker confirm his own firm's findings with regard to the effect of sand on the surface of castings and resultant blistering. He himself had proved without any shadow of doubt that castings, which were allowed to stand for two or three days in a pile of wet sand, produced excessive blisterings and boiling. Mr. Hoult produced samples to illustrate this point.

METALLURGICAL CONSIDERATIONS

By W. J. Colton, F.I.M., A.M.I.Mech.E.

Mr. W. J. Colton followed with a contribution dealing with metallurgical aspects, in the course of which he said:—

Co-operation, of course, is essential between all parties concerned in order to achieve the desired result, which result is to obtain the commercially acceptable clean sound grade of casting. But can the enameller tell the foundryman the degree of soundness he requires other than that it shall enamel satisfactorily with the frit used?

Broadly speaking, in practice enamellers require that an increasing number of castings shall be capable of being enamelled using the directly applied acid-resisting enamel. The application of a grip coat is undesirable for either economic or technical reasons, although in some instances this practice has been resorted to. Some casting conditions can, it seems, be overcome by the double application using ground and finishing coats. The increasing demand for both domestic and industrial enamelled ware over the past two decades has of necessity meant an increase in mechanical founding units to cope with the demand for castings. In order to maintain the increased output, operational plant control has to be greatly extended in order to maintain more uniform conditions of material and operation. Apart from other considerations, any undue variations of metal, or sand conditions, or foundry technique, have serious consequences in loss of output, either on account of loss of time or increase in scrap. So, from the point of view of making castings alone, one has to increase control in introducing a mechanised plant. There is, therefore, an increasing demand for quantity, combined with a more exacting requirement of enamel finish, for production of clean, sound castings, provided that the design of the job is suitable. Here the co-operation between the designer and the foundry is essential to obtain a clean casting. It is a joint responsibility between metal, sand and foundry technicians, and the standard of finish required should be determined between the user and supplier. Castings having a satisfactory finish, free from gas holes and obvious sand inclusions, are being produced on mechanised plants today in large quantities, yet faults in enamelling are far too frequent. The major fault is that of "boiling." There seems to be a general agreement on this, and it may be a general feature all over a surface, or a local boiling, occurring in isolated areas in a casting. When the defects occur in isolated areas, they are, in the main, repeated on the same type of casting.

In discussing metal in relation to such faults, mention of sand and founding methods cannot be eliminated, since they are interdependent in their effects and cannot, therefore, operate in watertight compartments if satisfactory results are to be obtained. There are two basic requirements for metal: (1) that metal composition shall be suitably balanced to give a dense, grey structure in the sections of a casting, and (2) the metal temperature shall be sufficient for the composition to give adequate fluidity for casting the job. These requirements are controlled by metal mixture, and melting and pouring techniques. Our main national type of pig-iron is the high phosphorus grade and, invariably, this is the type used for making castings for enamelling. The foundry methods for light castings have been built up on this iron over a long period of time. However, a paper published by the B.C.I.R.A. in October, 1950,* indicates that satisfactory enamelling can be obtained on light castings having a quite different composition, particularly with respect to two phosphorus compositions, one having 2.1 to 2.3 per cent. silicon and 0.2 to 0.3 per cent. phosphorus, another with a phosphorus 0.65 to 0.8 per cent., with a silicon of 2.5 to 2.7 per cent. Experience in this direction indicates that a very wide range of compositions can be enamelled satisfactorily. Mr. Hoult has mentioned an example of 30 per cent. chrome iron, and the Author's foundry has also tried the 2½ per cent. silicon and 1½ per cent. chromium, which also enamelled satisfactorily. Composition, therefore, may be much wider than is generally supposed as far as ability to be enamelled is concerned. However, this does not detract from the necessity of maintaining composition within limits suitable to the class of work. Here the Author quoted examples related to enamelling behaviour.

Structural variations occur in castings having different sectional thicknesses, the larger the section the greater the change in structure and the chance of internal porosity and surface sinks. These states are due to the different rates of cooling of the metal from the liquid state in the mould. Again, suitable design can assist greatly in minimising these effects. Equally so, in enamelling the different masses, the result of varying the rates of heating and cooling in the furnace probably produces a delayed rate of fusion of the enamel on the larger areas. It has been said that among the leading functions of control, the two factors for metal were metal mixtures and melting and pouring practice. With metal mixtures it is the general practice to use pig-iron and both domestic and the bought-in types of scrap, in varying proportions. These, in the main, vary

* The Use of Low Phosphorus Cast Iron for Light Castings.

Symposium on Enamelling of Cast Iron

from 40 per cent. to 60 per cent. each in either direction with an average of about 50 per cent. of pig and scrap. Unfortunately, today—and the difficulties of the founder are by no means decreasing, particularly with the supply problem—it is necessary to accept compositions of pig-iron wider than one would normally have done a little while ago. To maintain a specific composition limit it is not infrequent, at this time, to have to make alloy additions to the cupola charge, dependent upon the calculated composition of the mixture. Quantities of ferro-silicon, for example, may have to be added to the cupola to bring the silicon to the desired rate.

Similarly with manganese; to obtain the required manganese/sulphur balance it is the Author's practice to analyse every wagon of pig-iron that is received in the works so that it is known what is being handled. The composition suitable for the type of castings being made, in order to give satisfactory structure wear, has an average composition of about: T.C., 3.15; Si, 2.65; Mn, 0.65; S, 0.09; and P, 1.1 per cent. If the silicon varies between 2.4 and 2.9 per cent. it is satisfactory, and the sulphur can go up to 0.10 or 0.15 per cent. or even more, providing there is a satisfactory balance between the manganese and the sulphur.

The melting is done in a cupola furnace mechanically charged. The only special attempt to get clean metal is that the siphon-brick method of tapping is used. As the metal is tapped from the furnace the temperature on entering the shank varies between 1,340 and 1,400 deg. C., and the pouring temperature generally between 1,340 and 1,360 deg. C. It is sometimes dangerous, however, to generalise in this manner, because in the Author's experience, pouring temperature is dependent upon the casting being made.

Mention has been made of plants operating on synthetic and on naturally-bonded sand, but it is more general, perhaps, for light-castings to use natural sand rather than synthetic. However, good results are being obtained from all types and the choice seems to depend very largely upon operating conditions in any particular foundry. The Author's foundry at the moment is using a natural base sand to which has been added clay in order to increase the strength to suit operating conditions. It also contains coal-dust. The practice is to take hourly samples from the continuous plant for moisture and green strength, and plot the results on a control chart, using that to determine the sand plant additions necessary to maintain the limits. A moisture content of 6½ to 7½ per cent. with a permeability of 19 to 23 and a strength of not less than 10 to 12 lb. per sq. in. (minimum 10) is used. This is, in the main, a very strong sand as far as naturally-bonded sand is concerned, but the company found that is necessary for the plant conditions.

Annealing

There seems a very wide diversity of opinion as to whether annealing is necessary or not, and whether the effect is good or bad. The annealing temperatures used by different concerns seem to vary very widely, anything between 750 and 900 deg. C.; 750 to 800 deg. C. is perhaps more common. An enamel fusion temperature of about 750 deg. C. corresponds closely to structural change that takes place in iron carbon alloys, which is accompanied by a change in volume.

It has often occurred to the Author that useful work could be done in investigating the effects of sectional variations in the castings on the differential rates of heating and cooling, resulting from the different sectional masses and the phenomena of "boiling" on the enamelled surface.

DISCUSSION

MR. CHATTERTON: (metallurgist, from Radiation Limited) said that this organisation at the moment ran eight mechanised plants, turning out about 20,000 tons of castings a year. Having heard various speakers he wondered by what skill or by what good luck any good castings at all had been produced; what with sulphur in the sand, variation in composition, and unskilled labour. His group suffered from these difficulties but had got down to a point where rigid specifications for everything were laid down. Scrap castings were produced but there was no doubt about it that 75 per cent. of the scrap castings found was due to variations from the techniques laid down. It invariably took a long time to identify the variation, but that variation from standard was the cause of the scrap. Mr. Chatterton was happy to state that, unlike most people he was able to tell the enamellers that the enamel was not so good as it had been previously, and they could do something about it. He agreed with Mr. Hoult that 30 per cent. chromium iron castings could be enamelled readily, that was simply because that amount of chromium was present, and the carbides which are the cause of trouble are in that case stable. On the other hand he would like to see the results of putting 0.3 per cent. of chromium in his iron. He had trouble himself in enamelling such material.

Lastly, on the problem of dissolved gas: If cupola practice was such that it did not deviate from a set of circumstances laid down, then surely from day-to-day the amount of gas in the irons would be the same. That was not quite possible at the moment, but it was almost possible in some American foundries. For instance they varied from day to day the volume and pressure of air entering the cupola according to the daily temperature, humidity, or pressure.

Speaking on behalf of MR. TODD, MR. GRAINGER said that some little time ago, a foundry had approached an ordinary jobbing enamelling firm to undertake certain work of cast-iron enamelling, which they had accepted. When the first load had been delivered, the managing director of that company had been sent for to see the remarkable quality of the casting sent for enamelling. It was a casting perhaps 2 ft. 6in. by 2 ft. wide, which looked perfect, with no blemish, and no blowhole, which obviously would enamel well, and did. Those supplies had continued for approximately 18 months, and the percentage of scrap in enamelling was negligible. In due course, that company, which had been acquired by our friend's organisation, eventually introduced the experts, mechanics, engineers and chemists, and had mechanised the foundry. In the old days, these particular castings had been made on the floor by craftsmen at daywork rates, every man taking a pride and an interest in his job. Now the sand was mechanically supplied to moulding machines and the company had never made a good casting for enamelling since. That was a challenge to Mr. Chatterton.

Delayed Defects

MR. STONE said that co-operation was an important factor between enameller and foundry. With regard to Mr. Walker's success in obtaining results by the welding of defects, Mr. Stone thought that would be a costly way of doing it. Mr. Walker had also mentioned that he had succeeded in using mild-steel wire; Mr. Stone said that on examination of those castings a month or two after enamelling he felt quite sure that in ninety-nine out of one hundred cases there would be a small ring showing in the enamel equal to the diameter of the wire that he had plugged it with, and the enamel would eventually chip off.

MR. MARSHALL said that he thought there should be more co-operation with the frit manufacturers. He had never heard of a frit maker co-operating and explaining how the frits were made, how they developed them or the combinations, or what they could do to help foundrymen and enamellers' difficulties. Until that was done, he thought that enamelling troubles would continue.

MR. GRAINGER maintained that the majority of frits on the market were quite good enough to enamel any good casting; what was wanted was a straightforward old-fashioned cast iron on to which any enamel would go. The higher class of cast iron was required for the harder and rather more difficult acid-resisting enamels, but he contended that 99 per cent. of the trouble was in the foundry, and that it was foundry practice and not the technical man that was at fault.

MR. WALKER said he did not think that the people connected with foundries could be accused of complacency or even of self-assurance. They realised the many problems, and were doing a lot of work to try to solve them. He asserted that some enamel manufacturers were too complacent about a material they produced but which they themselves did not understand. No one could afford to be complacent, neither foundry people, enamellers, nor enamel manufacturers.

MR. GRAY said that he felt the trouble with castings today was right under the foundryman's nose, and perhaps not in the laboratory. He did not consider the major trouble with castings was with the composition, because, as an enameller, he could not understand why some very large foundries, mechanised or unmechanised, but with highly-skilled metallurgists, produced castings which were difficult to enamel; whereas a jobbing enameller could receive castings from a jobbing foundryman who had neither laboratory nor metallurgist, and those castings would enamel perfectly. He thought the answer was not in the laboratory but in foundry practice, and that it was up to the foundryman to find out what was causing the difference between the good and the bad castings. Having found that trouble and put it right, they would find that the enamellers would accord complete co-operation. Mr. Gray added that in Scandinavia they would not consider annealing castings before enamelling, and they got excellent results. Using the same enamel and same technique in this country, it was impossible to get good results without annealing in the majority of cases. He thought that why different results were obtained on different parts of the same casting was a question to which foundrymen should find the answer. When they had done that, they would find that what the enamellers had said in the original stages had been quite true.

MR. MACARTHUR thought that the co-operation which Mr. Walker emphasised would undoubtedly bring results. A number of theories had been expounded, particularly on surface blistering, as distinct from blistering from lugs, etc., and sulphur had been mentioned as the culprit. Those were still theories; there was still a lot of work to be done by way of proof, so that the information could be applied in the foundry.

The casting that Mr. Hoult showed, the small casting where he was able to say the fault was traced to the casting remaining in damp sand for three days, and which was reproducible, was of much interest. Mr. Hoult had described the conditions but not given the cause. Were those same conditions responsible for other conditions appearing on larger castings where there was surface blistering? Did they all boil down to a major factor that had yet to be identified in practice?

Influence of Craftsmanship Shortage

MR. LAITHWAITE expressed great interest in the discussion, but thought that in general speakers were dwelling too much on the past. Mr. Hoult had made a significant remark when he said (in essence) that the plain fact was that ironfounding was now an unpopular industry and people would not go into it under the old conditions. That seemed to be the keynote for the future, and it was necessary to understand that the old craftsman's approach could no longer be used and that mechanised foundries, and unskilled labour, were an essential part of the modern set-up. Progress both in foundry technique and in enamelling must be to a large extent a matter of experience and trial and error.

He disagreed with Mr. Walker's remark to the effect that the enamel maker was quite prepared to leave progress in the subject to the foundry side. Vitreous enamelling was developing a more scientific basis; if it were to survive it had to progress in this way. It was true that very little was known of the chemistry of enamels. Regarding the subject of cast irons, more knowledge of physical properties at a certain range of temperature was needed, and enamellers on their part were devoting most of their energy to the

Symposium on Enamelling of Cast Iron—Discussion

physical properties, the way to change viscosity, the effect on viscosity, the apparent viscosity and surface tension of materials added to the frit; all these things were significant.

MR. WALKER emphasised that co-operation between foundrymen and enamellers would strengthen their positions, and as a result he felt sure that the British as a nation would take the lead as vitreous enamellers of cast iron.

DR. NIKOLEWSKI, commenting on an observation made by Dr. Hurst, said that he had seen during the war some estimations by the big Swiss company, Louis de Roll Iron Works, Limited. The amount of rejects in their enamel plant was parallel to the reported analysis of gas contained in the castings. Extended research was conducted in finding sources of gas in castings. One German firm went to the extent of drying all raw materials and air used for blowing the cupola. Dr. Hurst's contribution was very important; but enough was still not known about the relation between the composition and the gas content of cast iron. He stressed the solubility of hydrogen during the storage of castings; many people would find that if castings were enamelled after 24 or 12 hrs., the rejects were low, but if the storage was for any longer period there must be some annealing, otherwise the number of rejects would increase.

Dissolved Gas

He had had some experience of some 20-year-old cast-iron cooker parts on which, after re-enamelling, the amount of blistering was commensurate with the original amount of rust—the more rust the more blistering. This was not because of the original rust (which was, of course, removed), but because of the hydrogen involved in the rusting process being absorbed by the cast iron. He felt that the amount of gas dissolved in iron was the major clue to the troubles in the enamelling industry.

Another very important line of research was the question of sulphur on the skin of the casting. He thought the Germans had found out some more about this and that British effort should be concentrated on the subject.

MR. S. HALLSWORTH disagreed with Mr. Walker's remarks about frit suppliers, and maintained that the frit supplier did not say the composition of enamel was immaterial, even within limits. He thought that the question of facing sands and blowholes covered 50 or 60 per cent. of the troubles which were met in cast-iron enamelling.

MR. PEDDER referred to the emphasis due to the desirability that annealing should be carried out at a higher temperature than that at which the enamel was worked, because the higher the temperature the more gas was evolved from cast iron.

MR. GRAINGER, summing up, said that Mr. Todd fully appreciated the technical considerations which had to be borne in mind when making cast iron for enamelling, but, first and foremost, he asked the foundry to look after the mechanics of their operations in order to give him a homogeneous casting, free from defects and holes, and of good design; after which to concentrate on the more technical problems to make it more nearly perfect.

MR. STONE considered that the meeting had turned out very satisfactorily, and congratulated all concerned.

The PRESIDENT said that the response which the committee had already received to the circular asking for co-operation from individual manufacturing firms who were members of the Institute of Vitreous Enamellers had been gratifying. On the subject of cast iron there was too much opinion, and not enough facts. If facts, reinforced by quantitative data, could be obtained they would be in a better position to get knowledge and guidance.

With regard to one point on the subject of dissolved gases and cupola standardisation, raised by Mr. Chatterton, Dr. Hurst said he knew of a certain cupola operating in producing castings, fortunately not for vitreous enamelling, which was using pig-iron from a certain blast furnace in this country. The average hydrogen content of the pig-irons from that blast furnace was anything from 4 to 6 ml. of hydrogen per 100 gm. But there had been a consignment recently with 40 ml. of hydrogen per 100 gm. Dr. Hurst wondered what would happen to Mr. Chatterton's control conditions in such a case. The kind of thing investigated was how did that pig-iron originally contain 40 ml. of hydrogen, and what happened to the hydrogen when it was charged into the mixture in the same proportion as the pig which, hitherto, has had no more than 6 ml. of hydrogen. The question of the determination of the dissolved gas in the first place was a very difficult problem because of the complicated apparatus involved to conduct the operation with any degree of accuracy. However, the I.V.E. committee had been given access to the apparatus in his laboratory together with the apparatus in certain other laboratories which were equipped for dealing with this matter.

Iron-ore Imports

Imports of iron ore in August and the first eight months of the year, with comparative figures for 1950, are shown below. There were no imports of manganiferous ore during the first eight months of this year. In the first eight months of 1950, 10,876 tons of manganiferous ore were imported, against 6,976 tons in the corresponding period of 1949.

Country of origin.	Month ended August 31.		Eight months ended August 31.	
	1950.	1951.	1950.	1951.
	Tons.	Tons.	Tons.	Tons.
Sierra Leone	60,350	68,320	533,461	376,461
Canada	—	147,225	5,525	314,295
Other Commonwealth countries and the Irish Republic ..	1,750	2,012	19,121	17,218
Sweden	325,188	397,005	2,378,231	2,219,877
Netherlands	8,071	7,644	25,728	27,538
France	35,716	23,371	260,181	251,011
Spain	51,245	68,458	543,029	557,012
Algeria	177,826	171,839	1,057,793	960,764
Tunis	32,350	36,415	350,474	334,249
Spanish ports in North Africa	21,129	25,725	318,576	228,081
Morocco	14,100	31,452	220,358	193,963
Other foreign countries	35,401	16,527	167,537	122,672
TOTAL	763,126	995,993	5,880,614	5,603,141

Personal

MR. J. HARVEY HOWELLS has been appointed secretary to the United States Committee of the Scottish Council (Development and Industry) in succession to MR. W. E. MATHER.

MR. G. GORDON JACKSON, managing director of the Engineering Centre, Limited, has been appointed to succeed MR. H. M. MACINTYRE as Scottish Controller for the Ministry of Supply.

FOUNDRY SUPERINTENDENT of Richmonds Gas Stove Company, Limited, Warrington (Lancs), MR. JAMES CARTWRIGHT was presented with a gold watch by the directors to mark his 50th year with the company.

THE LORD PRESIDENT OF THE COUNCIL has appointed PROF. SIR ERIC RIDEAL, F.R.S., Professor of Physical Chemistry at King's College, London, to be a member of the Advisory Council for Scientific and Industrial Research.

MR. M. W. BARLOW has resigned his position with the British Electro Metallurgical Company, Limited, on his appointment as manager of the ferro-alloy department of Foundry Services, Limited, of Nechells, Birmingham.

MR. D. M. BILSBY has gained an honours degree in electrical engineering. He already holds an honours degree in mechanical engineering at Birmingham University. Mr. Bilsby is a son of the director of the Crosswells Engineering Works, Langley Green, Birmingham.

DR. W. A. RICHARDSON, for 22 yrs. principal of Derby Technical College, intends to resign in August, 1952. He has been president of both the Derby and Derbyshire Chamber of Commerce, and the Newark Chamber of Commerce, and was awarded the O.B.E. in the King's Birthday Honours in 1935.

MR. E. A. GOODLAND, a former fuel engineer of the Workington Iron & Steel Company branch of the United Steel Companies, Limited, has left the post of manager of the Walsall district of the West Midlands Gas Board to take the appointment of general manager of the United Sulphuric Acid Corporation, Limited.

MR. JOHN D. RUTHERFORD, who has been appointed chief contract engineer of Bailey Meters & Controls, Limited, Croydon (Surrey), served his apprenticeship with Palmers Hebburn Company, Limited, Hebburn (Co. Durham), and joined Bailey Meters & Controls in 1943 after being with Clarke, Chapman & Company, Limited, and the old Newcastle Electric Supply Company, Limited.

DR. E. C. ROLLASON, formerly a delegate director and research manager of Murex Welding Processes, Limited, Waltham Cross, Herts, took up his appointment to the Henry Bell Wortley Chair of Metallurgy at Liverpool University on October 1. On leaving the company he was presented with an inscribed silver salver on behalf of the staff by Lt.-Col. J. F. Todhunter, general manager, who, after paying tribute to the work which Dr. Rollason had done, stated that it was not only a compliment to Murex, but to the welding industry as a whole that Dr. Rollason had been selected for his new appointment. In wishing him every success, Lt.-Col. J. F. Todhunter remarked that Dr. Rollason would now be one of the youngest professors of metallurgy in the country.

DR. W. I. PUMPHREY, M.Sc., Ph.D., F.R.S.A., is to succeed Dr. Rollason as research manager at Murex Welding Processes, Limited. Dr. Pumphrey was at Birmingham University where he graduated with a B.Sc. degree in 1942, and began work at the National Physical Laboratory on problems associated with the heat-treatment of steel. In 1944 he was awarded the degree of M.Sc. for work on the hardenability of steel.

British Standards Institution

Carbon-steel Castings for Surface Hardening (B.S. 1760:1951)

The British Standards Institution has recently published a new standard, one of a series of standards being prepared for steel castings for general engineering purposes. The specification covers the requirements for carbon-steel castings for surface hardening by a local heating and quenching process. Two grades are specified:—

Grade A is required to show a tensile strength of 40 tons per sq. in. and a surface hardness after hardening of 550 D.P.N.; and Grade B is required to show a tensile strength of 45 tons per sq. in. and a surface hardness after hardening of 600 D.P.N. The full chemical composition is specified for both grades. Inspection and testing are covered in detail and an appendix gives recommendations on the repair of castings by metal-arc welding. Copies of the standard may be obtained from the British Standards Institution, Sales Department, 24, Victoria Street, London, S.W.1, price 2s. post free.

International Nickel's Developments

In continuance of its expansion programme, the International Nickel Company, Limited, has now completed a double project at Creighton Mine, involving a total expenditure of $17,000,000. According to a statement issued by the Mond Nickel Company, Limited, work has entailed the sinking of a 2,050-ft. shaft, and the construction of a mill to deal with 10,000 tons of ore a day.

This is part of the programme on which $100,000,000 has already been spent, and which will bring the ore supplied by the company's underground mines from 5,700,000 tons in 1950 up to 13,000,000 tons in 1953.

I.B.F. National Works Visits, Oct. 12

Most of the parties for the various works visits arranged as a national function by the London branch of the Institute of British Foundrymen have now been completed. Functions for which applications may still be entertained are:—

Visit A.—Whole-day visit to the works of Belling & Company, Limited (electric stoves and equipment). Luncheon at Belling & Company, Limited.

Visit G.—Gillett & Johnston, Limited (bell-founders), Morgan Crucible Company, Limited (crucible manufacturers). Luncheon at Greyhound Hotel, Croydon.

In addition, Mr. W. G. Mochrie, the London branch secretary, reports that he would personally like to see a larger branch representation at the dinner and cabaret at the Holborn Restaurant in the evening as the London members are to act as hosts. In case there has been any misunderstanding by London members, it should be made quite clear that they are most warmly invited to take part in the event and can still make application.

The attention of foundrymen who have already arranged to join in visit A is particularly drawn to the amended arrangements. The visit to Dyson & Company which was to have occupied the morning, will, owing to unforeseen circumstances, not now take place. Instead, the whole day will be spent at Belling & Company, the engineering side, assembly and packing departments in the morning, and the foundry, where casting will be in progress, in the afternoon. There is, of course, no change in the departure time or luncheon venue.

Forthcoming Events

[Secretaries are invited to send in notices of meetings, etc., for inclusion in this column]

OCTOBER 8

Institute of Fuel

North-eastern section:—"Pore-size Analysis of Metallurgical Coke," by Dr. J. Gilchrist and Dr. A. Taylor. (Joint meeting with the Coke Oven Managers' Association) 6.30 p.m. at King's College, Newcastle.

Institution of Production Engineers

Yorkshire section:—"Some Aspects of Materials Handling in Industry in the U.S.A.," by E. G. Taylor, 7 p.m. at the Hotel Metropole, Leeds. A works visit has been arranged in connection with this Paper.

Institute of Metals

Scottish section:—Works visit to Henry Wiggin & Company, Limited, Thornliebank.

OCTOBER 9

Institute of British Foundrymen

Slough section:—"Running and Feeding of Castings," by H. B. Farmer, at 7.30 p.m. in the Lecture Theatre of High Duty Alloys, Limited, Slough.

Institution of Works Managers

Birmingham branch:—"Private Industry in a planned Economy," by Major C. C. Poole, 7 p.m., at the Grand Hotel, Birmingham.

Merseyside branch:—"Why Nationalised Industry cannot be Efficient," by Lewis C. Ord, 6.30 p.m. at the Adelphi Hotel, Liverpool.

Preston branch:—"The Responsibility of Management is securing Increased Productivity," by J. Ayres, 7 p.m. at Starkie House, Starkie Street, Preston.

Incorporated Plant Engineers

South Wales branch:—"Gears"—a lantern lecture by G. B. Ashton, 7.15 p.m. at the Institute of Engineers, Park Place, Cardiff.

Institute of Metals

South Wales section:—"Metallurgical Problems of Atomic Energy," by Dr. H. M. Finniston, 6.30 p.m. at the University College, Metallurgy Department, Singleton Park, Swansea.

Sheffield Metallurgical Association

"Sea Water Magnesia," by Dr. W. C. Gilpin, 7 p.m. at the Grand Hotel, Sheffield.

OCTOBER 10

Institution of Production Engineers

Liverpool section:—"Works Assignment and Incentive Payment on Semi-automatic Machines," by T. F. O'Connor, 7.15 p.m. at North-Western Gas Board, Radiant House, Bold Street, Liverpool 1.

Purchasing Officers Association

Tyneside branch:—"Brains Trust," 7 p.m. at the Crown Hotel, Clayton Street, Newcastle-upon-Tyne.

OCTOBER 11

Institution of Works Managers.

Wembley sub-branch:—"The Factories Acts," by R. K. Christy, 12.30 p.m. at "The Plough," Kenton Road, Kenton.

Incorporated Plant Engineers

Kent branch:—"Thermal Insulation of Buildings," 7.30 p.m. at the Queens Head, Maidstone.

Newcastle-upon-Tyne branch:—"Mechanical Handling," by R. J. Lester, 7.30 p.m. at the Roadway House, Oxford Street, Newcastle-upon-Tyne.

OCTOBER 12

Institution of Mechanical Engineers

North-eastern branch:—"Materials Testing," by M. Milne, 7 p.m. in the offices of Head, Wrightson & Company, Limited, Teesdale Ironworks, Stockton.

Institution of Production Engineers

Eastern Counties section:—"Valid Incentives," by E. C. Gordon England, 7.30 p.m. at Suckling House, St. Andrews Plain, Norwich.

Institute of Metals

Liverpool Metallurgical Society:—"The Problem of the High-temperature Oxidation of Metals," by Prof. A. Preece, 7 p.m. in the Lecture Theatre, Electricity Service Centre, Whitechapel, Liverpool.

Institute of British Foundrymen

National works visits day, organised by the London branch. (Further details were printed in the JOURNAL of September 20, page 339.)

OCTOBER 13

Institute of British Foundrymen

West Riding of Yorkshire branch:—"Brains Trust," 6.30 p.m. at the Technical College, Bradford.

Newcastle-upon-Tyne branch:—Works visit (further details from the secretary).

Scottish branch:—Presidential address by Mr. R. R. Taylor, followed by "A Production Aid in the Steel Foundry," by Mr. G. D. McNair, at 3 p.m. in the Royal Technical College, Glasgow.

Board Changes

F. PERKINS, LIMITED—Sir Richard E. Yeasby has been appointed to the board.

LEADBEATER & SCOTT, LIMITED—Mr. D. C. Jeffrey has joined the board and has been appointed chairman.

CHARLES ROBERTS & COMPANY, LIMITED—Mr. Leonard Rose, commercial manager, has been elected a director.

HATTERSLEY & RIDGE, LIMITED—Mr. C. Gilbert Green and Mr. H. G. Edwards have been appointed joint managing directors.

RUSTON-BUCYRUS, LIMITED—Lt.-Col. P. O. Ionides has retired from the board and Mr. J. C. P. Brunyate has been appointed a director.

BRITISH METAL CORPORATION, LIMITED—Mr. K. A. Creery, president of the British Metal Corporation (Canada), Limited, has been appointed a director.

NEEPSEND STEEL & TOOL CORPORATION, LIMITED—Mr. A. Hattersley has retired from the board, and Mr. C. G. Green has been appointed a director to fill the vacancy.

METAL INDUSTRIES, LIMITED—Mr. R. W. McCrone, one of the founder directors of the company, has succeeded Sir J. Donald Pollock as chairman. Sir Donald, who has also retired from the board, has been appointed honorary president of the company.

Foundry Course at Chesterfield Technical College

A series of six lectures on foundry subjects is to be held in Chesterfield Technical College at 7 p.m. on the second Wednesday of each month from October to March. The following are the guest lecturers and their subjects:—Mr. J. Bamford, on "Training for the Foundry Industry"; Mr. C. R. van der Ben and Mr. H. Haynes, on foundry work in general (together with a film, "The Production of Castings for Internal Combustion Engines"); Mr. S. A. Horton, on "Patternmaking in Foundry Production"; Mr. S. H. Russell, on "Productivity Methods in Jobbing Foundries as compared with those in the U.S.A."; Dr. J. E. Hurst, on "Cast Iron Research and Development"; and Mr. E. Wharton, on "Foundry Sands."

Forty Years Ago

In the October, 1911, issue of the FOUNDRY TRADE JOURNAL, there appears what was probably the first description of the Stock converter and its products, one of which is a goblet having but $\frac{1}{16}$ in. thickness of metal (steel). An article from Germany deals with the magnetic treatment of rubbish to recover iron, but not sand. The plant crushed cupola and converter slag, and recovered much scrap. Another article by Dr. Moldenke dealt with the briquetting of metal borings. Other articles dealt with cupola practice, match plates and the annual meeting of the Institute of Metals. From the news it is learnt that the name of the firm of Thomas Farrar, Limited, had been changed to Walter Slingsby & Company, Limited.

William Jacks & Company's Dividend

A final dividend of 15 per cent. on the ordinary shares for the year ended December 31, 1950, was recommended by the directors of William Jacks & Company, Limited, metal merchants, of London, at the annual meeting held on September 25. An interim dividend of 10 per cent. was paid earlier in the year. The dividend on the preference shares is 5 per cent.

Imports and Exports of Iron and Steel in August

The following tables, based on Board of Trade returns, gives figures of imports and exports of iron and steel in August. Figures for the same month in 1950 are given for purposes of comparison and totals for the first eight months of this year and of 1950 are also included.

Total Exports of Iron and Steel

Destination.	Month ended August 31.		Eight months ended August 31.	
	1950.	1951.	1950.	1951.
	Tons.	Tons.	Tons.	Tons.
Channel Islands ..	791	777	5,619	6,164
Gibraltar	130	130	1,082	523
Malta and Gozo ..	230	311	3,031	2,242
Cyprus	602	157	6,054	3,159
Sierra Leone	896	309	3,187	3,498
Gold Coast	2,056	1,304	17,601	12,156
Nigeria	4,534	3,202	41,009	37,653
Union of South Africa	16,162	8,463	116,652	89,163
Northern Rhodesia ..	2,582	676	20,480	9,565
Southern Rhodesia ..	5,069	2,623	51,689	25,518
British East Africa ..	8,377	4,558	66,518	53,244
Mauritius	806	535	6,270	4,722
Bahrein, Kuwait, Qatar and Trucial Oman ..	387	949	4,990	5,126
India	10,774	6,014	71,568	62,878
Pakistan	6,130	4,974	66,315	52,610
Malaya	5,825	6,166	53,377	50,596
Ceylon	1,888	1,426	24,474	18,797
North Borneo ..	326	137	4,297	3,529
Hongkong	2,325	1,734	31,213	39,975
Australia	46,962	23,111	252,540	228,328
New Zealand ..	12,072	6,032	115,645	68,864
Canada	22,539	25,630	123,906	175,193
British West Indies ..	5,219	8,208	42,949	45,333
British Guiana ..	432	289	5,067	3,857
Anglo-Egyptian Sudan	1,196	608	11,815	6,209
Other Commonwealth	1,354	857	9,712	7,732
Irish Republic ..	7,197	5,056	61,322	61,929
Soviet Union	—	—	513	2,236
Finland	10,221	3,033	49,091	24,588
Sweden	7,441	9,695	59,405	72,536
Norway	5,217	2,949	57,434	42,016
Iceland	250	227	3,244	1,971
Denmark	5,103	3,924	83,700	55,014
Poland	48	50	1,140	629
Germany	116	55	578	751
Netherlands	5,888	6,004	52,535	60,446
Belgium	433	785	8,193	8,238
France	2,146	221	17,016	4,178
Switzerland	354	397	7,383	7,899
Portugal	2,044	433	14,252	9,489
Spain	597	149	5,724	2,923
Italy	611	2,559	6,700	24,616
Austria	54	15	739	345
Hungary	7	—	328	23
Yugoslavia	1,967	780	10,424	6,940
Greece	1,343	292	4,890	2,036
Turkey	891	194	6,680	3,900
Indonesia	579	1,423	9,167	6,038
Netherlands Antilles ..	1,049	1,579	6,266	5,222
Belgian Congo ..	95	196	1,028	1,598
Angola	168	72	1,797	1,601
Portuguese E. Africa	235	345	3,198	2,553
Canary Islands ..	160	56	1,393	1,430
Syria	63	1,441	656	4,396
Lebanon	1,237	827	7,905	9,171
Israel	3,170	2,285	15,761	21,460
Egypt	4,212	4,077	41,955	30,625
Morocco	16	21	1,595	1,334
Saudi Arabia ..	237	251	2,001	565
Iraq	1,314	3,736	24,518	17,464
Iran	5,873	3,789	74,533	56,232
Burma	983	982	7,903	9,345
Thailand	145	1,602	3,905	11,456
China	18	—	1,979	4,619
Philippine Islands ..	236	227	7,124	2,595
USA	3,679	11,601	16,527	120,365
Cuba	180	188	1,314	2,873
Colombia	662	1,982	4,671	5,885
Venezuela	412	8,777	23,420	31,660
Ecuador	5	181	2,236	947
Peru	397	343	8,059	8,794
Chile	433	216	11,600	5,937
Brazil	2,735	1,130	22,384	15,008
Uruguay	683	463	6,150	8,490
Argentina	5,043	3,067	45,137	31,455
Other foreign ..	1,898	1,839	13,141	12,749
TOTAL	247,509	198,694	1,975,674	1,842,704

* The figures for 1951 are not completely comparable with those for previous years.

Total Imports of Iron and Steel (tons)

From	Month ended August 31.		Eight months ended August 31.	
	1950.	1951.	1950.	1951.
India	—	5	22,884	7
Canada	2,678	4,842	26,701	31,881
Other Commonwealth and Irish Republic	155	100	1,117	1,059
Sweden	952	1,548	7,993	14,511
Norway	4,213	5,100	33,944	34,331
Germany	2,540	1,970	57,489	14,496
Netherlands	457	5,890	35,870	48,651
Belgium	1,094	16,406	69,462	113,478
Luxemburg	—	6,489	30,108	54,584
France	23,080	25,956	192,469	165,574
Austria	801	5,985	3,286	18,781
USA	4,695	3,456	46,027	23,702
Other foreign ..	184	1,296	5,212	3,151
TOTAL	40,849	79,043	533,162	524,206
Iron and steel scrap and waste, fit only for the recovery of metal	177,895	47,941	1,602,088	425,357

Exports of Iron and Steel by Product (tons)

Product.	Month ended August 31.		Eight months ended August 31.	
	1950.	1951.	1950.	1951.
Pig-iron	2,549	540	18,220	14,197
Ferro-alloys, etc.—				
Ferro-tungsten ..	69	3	757	296
Spiegeleisen, ferro-manganese ..	115	25	1,356	807
All other descriptions	90	37	1,041	733
Ingots, blooms, billets, and slabs	433	121	4,050	5,030
Iron bars and rods ..	336	566	2,927	6,608
Sheet and tinplate bars, wire rods ..	3,382	689	8,943	9,691
Bright steel bars ..	3,915	936	28,615	23,504
Alloy steel bars and rods	1,696	1,391	10,205	10,826
Other steel bars and rods	20,737	7,685	159,251	128,771
Angles, shapes, and sections	10,794	9,289	96,113	113,018
Castings and forgings	563	1,024	5,452	7,807
Girders, beams, joists, and pillars* ..	5,550	2,635	43,908	28,732
Hoop and strip ..	10,623	6,707	73,653	48,245
Iron plate	422	225	1,917	1,625
Tinplate	20,877	17,898	104,028	166,423
Tinned sheets ..	152	83	2,009	1,841
Terneplates, decorated tinplates	140	90	651	916
Other steel plate (min. ⅛ in. thick) ..	25,300	15,230	214,200	185,691
Galvanised sheets ..	8,896	3,529	77,006	36,566
Black sheets	10,947	11,230	93,016	103,262
Other coated plate ..	1,045	704	8,021	6,454
Cast-iron pipes up to 6 in. dia.	6,675	7,789	51,944	53,828
Do., over 6 in. dia. ..	5,799	7,296	54,705	48,610
Wrought-iron tubes ..	28,088	40,121	237,611	274,092
Railway material ..	24,668	12,452	205,069	158,203
Wire	7,406	4,220	50,261	40,962
Cable and rope ..	3,026	2,235	23,001	20,234
Wire nails, etc. ..	2,206	2,021	14,567	19,329
Other nails, tacks, etc.	587	790	3,944	6,954
Rivets and washers ..	658	551	5,296	4,820
Wood screws ..	253	356	2,459	2,594
Bolts, nuts, and metal screws	2,757	2,520	20,965	18,627
Baths	1,082	1,264	9,530	9,430
Anchors, etc. ..	755	718	6,130	6,004
Chains, etc.	703	858	6,847	7,537
Springs	555	399	6,014	4,241
Holloware	5,402	2,429	55,993	24,021
TOTAL, including other manufactures not listed above ..	247,509	198,694	1,975,674	1,842,704

News in Brief

The Combustion Engineering Association intend to proceed with the holding of their conference on "Meeting the Fuel and Power Shortage," called for October 9 and 10 at the Dorchester Hotel.

Further capital is being raised by Davy & United Engineering Company, Limited, by an offer of 47,069 £1 shares at par to stockholders registered on August 21 in the proportion of one for every £20 of stock then held.

Powder Metallurgy, vol. 9 of the Selection Government Research Reports, has been published by His Majesty's Stationery Office for the Department of Scientific & Industrial Research, price 18s., or by post 18s. 5d.

Orders valued at £7,000,000 placed by the Ministry of Supply with Leyland Motors, Limited, Leyland (Lancs), bring to total value of orders secured by the company during one calendar month to over £13,000,000.

An unofficial strike of 120 iron moulders employed by Jones & Campbell, Limited, Larbert (Stirlingshire), which began on September 17 over the question of the admission of trainees into the industry, ended on September 25.

Glenfield & Kennedy, Limited, hydraulic engineers, Kilmarnock, are to erect machine and assembly bays stores, etc., at their works for the maintenance department and tool room, at an estimated cost of £43,139.

An Order, effective from October 1, permits increases in the maximum prices of sulphuric acid, the additions being 14s. per ton on weak acid (77 per cent. H_2SO_4) and 27s. per ton on strong acid (more than 84.02 per cent. H_2SO_4).

Essential lubricating oil additives, formerly obtained from dollar sources, are now being produced on a large scale at the new Castrol plant at Stanlow (Ches). The additives give modern lubricants their detergent, anti-oxidant, and anti-corrosion properties.

H.R.H. the Duke of Edinburgh, K.G., F.R.S., has graciously accepted the office of president of the City and Guilds of London Institute for the Advancement of Technical Education to which he was duly elected at a special general meeting of the members of the Institute on September 21, 1951.

Metropolitan - Vickers Electrical Company, Limited, have appointed Mr. C. T. Scarf as chief engineer, Industrial Control Department, as from September 1st, 1951. He succeeds Mr. G. L. Newman, who is transferred to the staff of the Chief Electrical Engineer for special duties.

Mr. Waeles, the president of the *Association Technique de Fonderie* caps the story of the casting-up of a rat-run, so often told by the late Mr. James Ellis, by one where a river was caused to resemble a geyser because of molten metal escaping from a mould down a drain to end up in the bed of the stream.

It is reported that the Brush-A.B.O.E. concern, said to be the largest group of manufacturers of gas and oil engines in the world, has acquired control of a Keighley firm of Diesel-engine makers—H. Widdop & Company, Limited, Invincible Works, Greengate, Keighley—through a share deal involving about £200,000.

It is reported from Spain that a Guipuzcoan firm will set up the first Spanish pelletising plant for iron ore. A smelter for processing ore *in situ* will be opened near the Galician tin mines of the Fierro group. Siderurgica Industrial Ibérica, which has been authorised to produce 30,000 tons, will double Catalan pig-iron output.

The board of the Steel Company of Wales, Limited, has decided that, as from October 1, the Orb works at Newport (Mon), which had until then been operated as the Steel Company of Wales (Lysaght Works), Limited, will be operated as the Lysaght Division of the Steel Company of Wales, Limited. No changes in management or policy are involved.

Orders for two 9,500-ton ships for carrying sugar in bulk have been placed by the Sugar Line, Limited, with R. W. Hawthorn, Leslie & Company, Limited, Newcastle-upon-Tyne, and two have been ordered from Smith's Dock Company, Limited, South Bank, Middlesborough. The engines for all four vessels will be built by R. W. Hawthorn, Leslie & Company.

Scottish Ore Carriers, Limited, has been registered as a private company with a capital of £500,000 in £1 shares. The object of the new company is "to acquire ships or shares or other interests in ships and aircraft and to carry on the business of shipowners." A contract for two ore carriers for transporting iron ore to the United Kingdom has already been placed.

The secretarial, library, and information staffs of the research and development department of the United Steel Companies, Limited, Sheffield, have moved to Swinden Laboratories, Moorgate, Rotherham (Yorks). The metallurgical, chemical, physics, X-ray, and welding sections will be gradually transferred to the new laboratories in the relatively near future as the buildings become ready for occupation.

Following the annual general meeting of the British Valve Manufacturers' Association held in London last week, the executive committee elected as chairman of the association, Mr. N. P. Newman, J.P., managing director of Newman, Hender & Company, Limited, and past president of the Institute of British Foundrymen. Mr. Noël Newman succeeds Mr. E. Bruce Ball, managing director of Glenfield & Kennedy, Limited, who has held the chairmanship over the past three years.

The whole of the issued share capital of British Mechanical Productions, Limited, metal stampers and turners, etc., of London, and the General Accessories Company, Limited, electrical accessories manufacturers, of Bristol, has been acquired by the Edison Swan Electric Company, Limited, London. The new boards of the two companies will consist of Mr. H. Butterworth, chairman and managing director, Capt. C. R. Crook, Mr. S. Barber, Mr. J. W. Ridgeway, and Mr. E. Y. Robinson.

London Graduate Section of the Institution of Production Engineers are holding another week-end school at the Beatrice Webb House, near Dorking, on October 6 and 7. Papers to be presented are: "Time Saving on the Factory Floor as a Means to Higher Productivity" by L. E. Bunnett; "The Contribution of Production Research to Higher Productivity" by K. J. B. Wolfe, M.Sc.; and "The Approach to Manufacturing Problems Arising in a Medium-sized Precision Engineering Concern" by H. F. Plaut.

"Jack Scrap," symbol of the British Iron and Steel Federation's drive to step up the recovery of iron and steel scrap, has become mechanised. In an effort to assist in recovering agricultural scrap, Harry Ferguson, Limited, has equipped and staffed a mobile office to tour the Kentish countryside. Preceded by a federation daylight cinema van, the Ferguson unit is scheduled to visit the principal towns and villages. Having obtained full details regarding approximate quantity and locality of obsolete metal, this information will be sent to the London and Southern Counties Joint Scrap Committee of the federation, which will arrange for merchants to collect all scrap, making an on-the-spot offer to the farmer.

Raw Material Markets

Iron and Steel

The general engineering, motor, and textile foundries are heavily committed with both home and export business, while the light and jobbing foundries are also well employed. The completion of orders is delayed by the shortage of raw materials, chiefly pig-iron and scrap, with the result that the volume of new business inevitably remains restricted. There are no stocks of pig-iron available either at the foundries or the furnaces, so that users are solely dependent upon current production. Many foundries are compelled to accept pig-iron of low silicon content and their mixtures have to be adjusted accordingly, often necessitating the use of larger quantities of ferro-silicon. Difficulties are also being experienced in obtaining sufficient cupola scrap, particularly heavy cast-iron scrap.

There has been no expansion in the supply of the low- and medium-phosphorus irons. Little improvement is as yet shown in the supply of hematite pig-iron, but larger consignments of ore now being received confirm the hope that improved outputs will eventually result in increased deliveries to the foundries. Refined iron and Scotch foundry iron are fully absorbed, demands being much larger than the furnaces can cope with. The supply of high-phosphorus pig-iron is not sufficient to meet the needs of the light, jobbing, textile, and some of the engineering foundries. Available tonnages have, in fact, shown further reduction recently by the closing down of a furnace for relining.

Ganister, limestone, and firebricks are coming forward to meet requirements, and most grades of ferro-alloys can be secured to satisfy immediate needs. The foundries generally are receiving adequate supplies of foundry coke for current needs, but the fact that stocks are not being augmented is the cause of anxiety for the future.

The re-rollers are faced with a continued shortage of raw materials and reduced outputs. The supply of steel semis from home steelworks shows no improvement and there is little prospect of increased supplies from that source being available for the remainder of the year. It is evident that only increased tonnages of imported material will relieve the position. Heavy calls for all the products of the mills are being made, but outputs of sections, bars, and strip are on a much reduced scale and the tonnage available falls far short of the quantities required. The sheet re-rollers are also handicapped by the inadequate supply of sheet bars.

Non-ferrous Metals

With effect from Monday, the Ministry of Materials reduced its selling price of imported good soft pig-lead to United Kingdom consumers by £5 per ton to £175. This was made possible, the Ministry says, "by the improved terms of supply agreed with Commonwealth producers." The Ministry of Supply is making arrangements for corresponding adjustments in the controlled prices of scrap lead. No change will be made for the time being in the Ministry of Materials' selling price for zinc.

Although nothing further has transpired in regard to the suggestion that the Ministry of Supply was giving consideration to the advisibility of reducing maximum prices for copper scrap, it seems very likely that something will be done about fixing an upper limit for secondary copper ingots, which would presumably include English fire-refined brands normally offered for sale through channels other than the Ministry of Materials. There is, of course, today also an appreciable production of copper cathodes in the U.K. and it would seem to be only reasonable that some steps should be taken in respect of this material at the same time as fire-refined quality.

It is believed that the upper limit agreed for secondary copper ingots is likely to be within a pound or two of the official price. But whether the makers will be able to procure scrap at a level to make sales of ingots on such a basis possible remains to be seen. Generally speaking, the scrap situation does not show much change, for supplies are still scarce, and the flow of secondary material is well below the level at which all consumers would be satisfied.

Last week saw the progress of a number of conferences and discussions of interest to the non-ferrous industry in the United Kingdom. In London the Commonwealth conference on raw materials was opened, its opening session being addressed by the Minister of Materials, Mr. R. R. Stokes.

Allocations of copper and zinc for the fourth quarter of the year were announced by the International Materials Conference in Washington on Sunday. The largest allocation of both metals goes to the United States—333,770 tons of copper and 228,460 tons of zinc—while Great Britain is second in order of priority with 91,690 tons of copper and 60,250 tons of zinc. Apparently the fact that Chile did not see her way clear to agree to the pooling of 100 per cent. of her output had been a stumbling block to full agreement, but she has been allowed to retain 20 per cent. for disposal as she sees fit. It will be remembered that for some time now Chile has been disposing of this fifth of her copper output, the bulk of the 80 per cent. going to the United States market.

London Metal Exchange official tin quotations were as follow:—

Cash—Thursday, £970 to £980; Friday, £989 to £991; Monday, £1,000 to £1,002 10s.; Tuesday, £992 10s. to £997 10s.; Wednesday, £970 to £980.

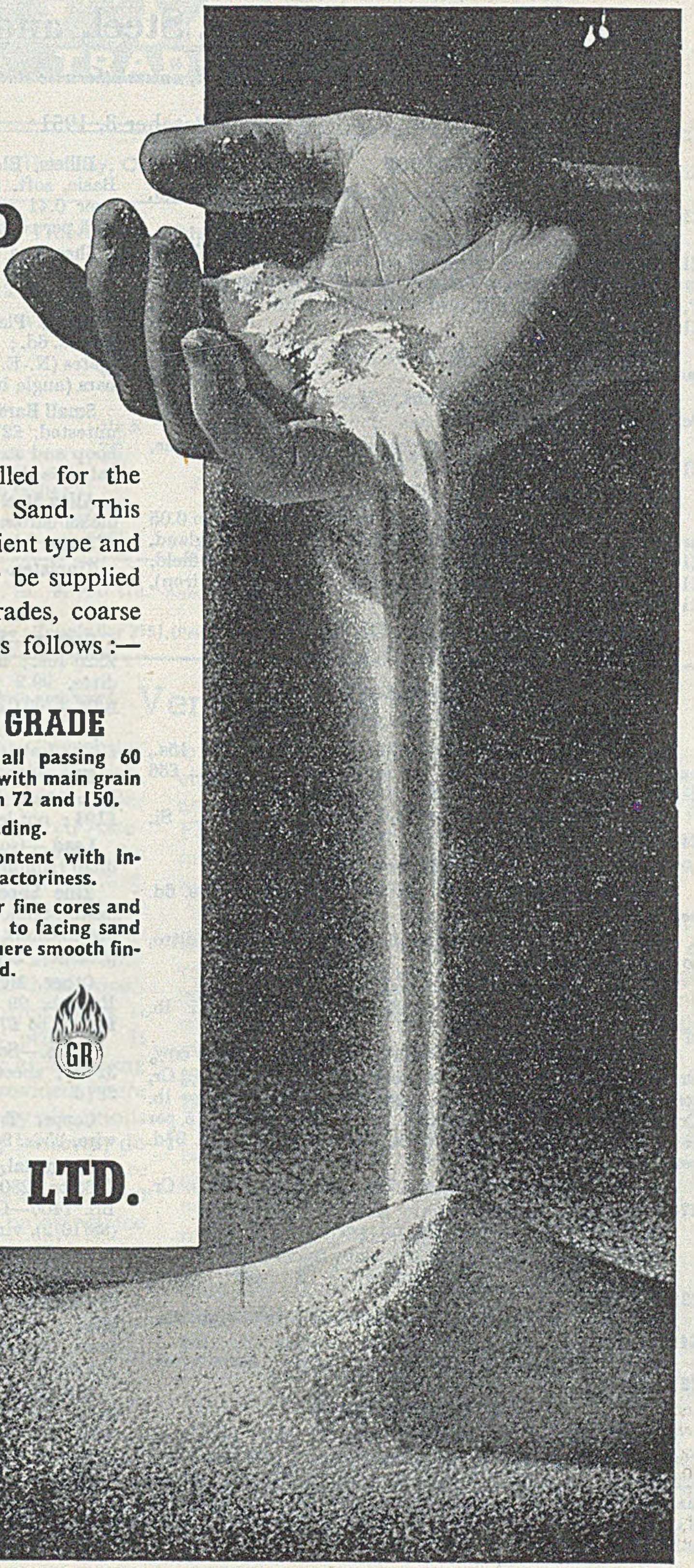
Three Months—Thursday, £920 to £925; Friday, £930 to £932 10s.; Monday, £935 to £937 10s.; Tuesday, £932 10s. to £935; Wednesday, £915 to £920.

Export of Copper Semi-manufactures

The Board of Trade has announced that the restrictions imposed sine April 1, 1951, on the export of semi-manufactures of copper and copper alloys are to remain in force for the last quarter of the year. This, it is stated, is made necessary by the continuing world shortage of the raw materials concerned, and the high level of demand for the semi-manufacturers for essential purposes. The export of semi-manufactures of zinc will continue to be permitted only in exceptional circumstances. Another announcement will be made before the end of the year.

For the two quarters since April 1, 1951, exports of semi-manufactures of copper and copper alloys have been restricted to approximately half the rate prevailing in the first six months of 1950. Applications for export licences should be addressed, fully documented, to the Export Licensing Branch of the Board of Trade, Atlantic House, Holborn Viaduct, London, E.C.1. The validity of existing licences is not affected.

Consent has been obtained from the Capital Issues Committee by Hilger & Watts, Limited, scientific instrument makers, of London, S.E.5, for the issue of a further £100,000 debenture stock which is being offered to existing debenture holders at par in the proportion of £50 of new stock for every £100 held. Additional finance is required to complete the erection of the company's pilot factory at Debden (Essex), made necessary by the increased cost of materials.



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

(Delivered, unless otherwise stated)

October 3, 1951

PIG-IRON

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

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

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

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

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

Cold Blast.—South Staffs, £17 5s. 6d.

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

Spiegeleisen.—20 per cent. Mn, £18 15s. 9d.

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

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered.)

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

Silicon Briquettes (5-ton lots and over).—2lb. Si, £48 5s.; 1lb. Si, £49 5s.

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

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

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

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

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

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

Chromium Briquettes (5-ton lots and over).—1 lb. Cr, £78 9s.

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

Metallic Chromium.—98/99 per cent., 5s. 11d. per lb.

Ferro-manganese (blast-furnace).—78 per cent., £39 17s. 1d.

Manganese Briquettes (5-ton lots and over).—2lb. Mn, £49 10s.

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

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—Basic: Soft, u.t., £21 11s. 6d.; tested, 0.08 to 0.25 per cent. C (100-ton lots), £22 1s. 6d.; hard (0.42 to 0.60 per cent. C), £23 19s.; silico-manganese; £29 15s.; free-cutting, £24 15s. 6d. Siemens Martin Acid: Up to 0.25 per cent. C. £27 16s.; case-hardening, £28 4s.; silico-manganese, £30 16s. 6d.

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

Sheet and Tinplate Bars.—£21 16s.

FINISHED STEEL

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

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

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

Tinplates.—54s. 8½d. per basis box.

NON-FERROUS METALS

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

Tin.—Cash, £970 to £980; three months, £915 to £920; settlement, £975.

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

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

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £210 10s.; rolled zinc (boiler plates), all English destinations, £208 10s.; zinc oxide (Red Seal), d/d buyers' premises, £205.

Other Metals.—Aluminium, ingots, £124; antimony, English, 99 per cent., £390; quicksilver, ex warehouse, £73 5s. to £73 15s.; nickel, £454.

Brass.—Solid-drawn tubes, 25d. per lb.; rods, drawn, 32⅞d.; sheets to 10 w.g., 29⅝d.; wire, 31¼d. rolled metal, 28⅜d.

Copper Tubes, etc.—Solid-drawn tubes, 26d. per lb.; wire, 254s. 9d. per cwt. basis; 20 s.w.g., 281s. 9d. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £265 to £280; BS. 1400—LG3—1 (86/7/5/2), £275 to £300; BS. 1400—G1—1 (88/10/2), £330 to £360; Admiralty GM (88/10/2), virgin quality, £330 to £360 per ton, delivered.

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

Phosphor Bronze.—Strip, 38d. per lb.; sheets to 10 w.g., 40⅛d.; wire, 42¾d.; rods, 38d.; tubes, 36¼d.; chill cast bars: solids 3s. 11d., cored, 4s. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Ingots for raising, 2s. 7d. per lb. (7%) to 3s. 6¾d. (30%); rolled metal, 3 in. to 9 in. wide × .056, 3s. 1d. (7%) to 4s. 0¾d. (30%); to 12 in. wide × .056, 3s. 1¼d. to 4s. 1d.; to 25 in. wide × .056, 3s. 3¼d. to 4s. 3d. Spoon and fork metal, unsheared, 2s. 10d. to 3s. 9¾d. Wire, 10g., in coils, 3s. 6⅛d. (10%) to 4s. 6⅛d. (30%). Special quality turning rod, 10%, 3s. 5¾d.; 15%, 3s. 10½d.; 18%, 4s. 2¾d. All prices are net.