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International Foundry Technology

The least publicised yet one of the most important activities of the Institute of British Foundrymen is the work it does in conjunction with the International Committee of Foundry Technical Associations. The Institute was a founder member in the year 1926, when a meeting was called by the late Mr. Paul Ropsy at Brussels. It was then that Mr. T. Makemson was appointed honorary secretary—a position he has held ever since. Under his wise leadership, conferences have been held in the United States, France, Belgium, Germany, Holland, Italy, Spain, Czechoslovakia, Poland, and London. The formation of the international body stimulated the creation of technical institutes in a number of countries—a movement which happily is still spreading.

It should not be imagined that prior to the formation of this committee there was no international foundry co-operation. The first important occurrence which gave outstanding pleasure to members of the British Foundrymen's Association in 1900 was the appointment of Mr. Pilkington, the president, to an international committee charged with the duty of preparing a specification for pig-iron. It was based on the question as to whether pig-iron should be graded by fracture or according to composition. Then, in 1922, during the annual conference of the Institute in Birmingham, there were a number of very important overseas guests and, at a private dinner party, it was decided that international support should be given to a congress to be held in the following year in Paris. Thus, in 1923, quite a large delegation of Americans, before crossing to France, were the guests of various branches of the Institute of British Foundrymen. Following this, there was a spate of invitations issued for international collaboration and the meeting called together in 1926 was for the regularisation of such activities.

The outstanding advantages of the existence of this committee are that a proper rota of international gatherings is assured; that there exists a focal point from which other international activities such as testing procedure and a foundry technological dictionary can radiate and, finally, the formation of mutually useful friendships—not only with overseas foundrymen, but also with one's own countrymen. Being together for a protracted period, such as a foreign trip involves, often creates lasting friendships. An interesting innovation is that Mr. Olivio, the Italian delegate, is giving a statuette of Perseus, a replica of the renowned work of art by Benvenuto Cellini, to the body organising an international foundry congress for presentation—at its discretion—to the individual who most merits such recognition. The composition of the committee is reasonably complete—Germany was re-admitted during a recent meeting in Buxton—but it would give pleasure to everybody if the Dominions could collaborate. The only difficulty, as far as we can see, is that of distance. However, in this age of air travel, distance is being rapidly neutralised. Some of the Dominions have larger and more active technical associations than those of the European members. The Netherlands foundrymen's association have issued a bound volume of the Proceedings of the Amsterdam Conference, an activity well worth emulating as providing a permanent record. In general, the Papers presented at these international conferences have not been outstanding, perhaps due to there being previously no assurance of such a permanent record being available.

Contents

Institute of Metals

Forty-second Annual Autumn Meeting

The forty-second annual autumn meeting of the Institute of Metals will be held in Bournemouth from Monday to Friday, September 18 to 22, inclusive. The meeting will open on the morning of September 18, when, after registering at the secretary's office, members will take part in a series of visits in the Southampton and Portsmouth areas. A visit for ladies has been arranged in the Bournemouth area for the afternoon.

The Autumn Lecture will be delivered on the evening of September 18, by Mr. E. E. Schumacher, chief metallurgist of the Bell Telephone Laboratories, Inc., Murray Hill, N.J., U.S.A., in the School Hall, Bournemouth School for Girls, Gervis Road, Bournemouth. It is particularly hoped that members who intend to take part in the meeting will arrive in Bournemouth in time to attend this lecture and to honour this eminent American scientist, who is coming to England at the special invitation of the Council.

The scientific and technical sessions, which will be held in St. Peter's Hall, Hinton Road, Bournemouth, will begin on the morning of September 19, when members will be officially welcomed by the Mayor of Bournemouth. There will be a civic reception and dance at the Pavilion on the evening of that day.

The Council hopes that there will be a large attendance at this meeting, the registration for which closes on September 11. The number of tickets available for several of the visits are limited and members are therefore requested to indicate their order of preference.

Works Visits

The establishments to be visited include:—The Admiralty Central Metallurgical Laboratory; Pirelli General Cable Works, Limited; John I. Thornycroft, Limited; Vickers Armstrong, Limited (Woolston); Harland & Wolff, Limited; Admiralty Materials Laboratory; Airspeed, Limited; Wellworthy Piston Rings, Limited.

Death of Mr. T. R. Walker

We regret to announce the death of Mr. T. R. Walker, M.A., who was for many years chief chemist with the English Steel Corporation. In this capacity he devoted much time and energy to a study of sand testing and, in 1938, published an elementary text-book, "Foundry Sands with Special Reference to Steelfoundry Practice." He was for 21 years honorary secretary of the Sheffield branch of the Institute of British Foundrymen, which he joined in 1918. A few years ago he presided with distinction over the branch, but it is as secretary that he will be best remembered. His sterling work in this connection was recognised at the Buxton Conference last June by the award of a meritorious-services medal. Though he was present, he was too ill to make a formal speech of acknowledgment. He was first holder of the Bronze Medal award by the City and Guilds of London for foundry practice and science. The Institute of British Foundrymen was represented at the funeral service by Mr. J. G. Bailes and Mr. J. H. Pearce and the English Steel Coroporation by Dr. C. J. Dadswell and Mr. W. D. Pugh.

Lincoln Electric Company, Limited, of Welwyn Garden City, Herts, have developed and placed on the market two new types of welding rod known as Multiweld and Positionweld—the latter specially compounded to work in vertical and overhead positions.

Film Review

NORTH BRITISH

This industrial documentary has been produced for the North British Locomotive Company, Limited, of Glasgow, by Mr. Edward Cook, of the Big Six Film Unit. By now, it is becoming obvious that films made under this direction have a distinct and readily recognised style. Clear photography, ordered sequence and a dignified yet blatantly advertising script are their characteristics. An essential is, of course, that the commentator must be an enthusiast on the subject shown, whether he be a member of the staff of the works illustrated or a professional announcer. Because of this "enthusiasm," generally speaking, a member of the firm is to be preferred. Locomotives make a good subject for an industrial documentary. They attract human interest from the nursery stage to dotage, whilst the component parts are not unknown to the layman. The film concentrates on the making of these components, their assembly and the handling of the finished engine. The shots in the foundry are practically all close-ups, but sufficient is shown to underline the meticulous care in moulding and core-setting. The ladle used for transporting the liquid metal from the cupola to the moulds was ancient and ill-favoured, and compared so very badly with the wonderful special-duty automatics installed in the machine shops. 'Twas ever thus! The object of this film is to interest—mainly overseas audiences—in the engineering facilities existing in this works and the painstaking care bestowed on the production of each locomotive. This has been remarkably well achieved. V. C. F.

Dust and Fumes in Iron Foundries

The Joint Iron Council, in association with the Council of Ironfoundry Associations, has decided to intensify work upon problems of dust and fumes in iron foundries, and to provide an advisory service on how these may best be dealt with in foundry practice. The work is being carried out through the British Cast Iron Research Association, which is largely financed by the Joint Iron Council. A special committee of the Research Association, entitled "The Foundry Atmospheres Committee," is supervising the work. Close collaboration is being maintained with the Joint Standing Committee on Conditions in Iron Foundries set up by the Factory Department of the Ministry of Labour.

Association of Bronze and Brass Founders

The April/June Bulletin (No. 21) of the Association of Bronze and Brass Founders is much larger than usual and with this increased size comes an improved service to the industry. The branches are maintaining their activity and interest. Crucible life is receiving added attention, but still more co-operation from the members is sought. The bulletin announces that the Council had invited Mr. Frank Hudson, Mr. V. C. Faulkner and Mr. F. C. Evans to become honorary associate members and that these invitations had been accepted. Other subjects having the attention of the Association are metal losses, specifications, and the availability of raw materials and their prices.

British Jeffrey-Diamond, Limited, has opened a branch office at Dock Chambers, Bute Street, Cardiff (telephone: Cardiff 1070), with Mr. F. Jackson as the district technical manager. By amicable mutual agreement, the company's present agency arrangement with Llewellin Evans & Major, Limited, will terminate on July 31.

Spectrographic Analysis in the Grey-iron Foundry*

By E. J. Ronnie, L.I.M. and M. M. Hallett, M.Sc., F.I.M.

M. M. HALLETT

E. J. RONNIE

Although the first Paper in this country on the application of the spectrograph to the analysis of grey cast iron was presented to the Institute by Ling, PcPheat and Arnott[1] seven years ago, the further application of the method has been relatively slow. The first regular large-scale application was described by Hurst and Riley[2] in a valuable Paper, which was published in 1946. A great deal of useful work has been done by the British Cast Iron Research Association and an important new technique has been described by Argyle and Price.[3] In 1946 the Authors decided that the method was sufficiently well established to justify installing the necessary equipment, and this Paper is now presented as an account of their experiences during operation in the last two years, in the hope that it may be useful to other founders considering the possible use of the method.

THE PAPER IS DIVIDED into two main sections. In the first section are discussed those features of general interest dealing with the applicability of the spectrograph, its accuracy, the staff and space needed to operate it, and its advantages and disadvantages. The second section contains a more detailed account of the precise methods adopted to achieve the results described, and is intended to be read by the specialist interested in the application of spectrographic analysis.

PART I—FEATURES OF GENERAL INTEREST

Applicability and Accuracy

The spectrograph is not suitable for determining carbon, phosphorus and sulphur, but is suitable for the determination of virtually all the other elements (other than gases) likely to be present in cast iron, including those normally reported only as traces. When the apparatus was first installed, it was expected that it would be suitable for the analysis only of relatively low-alloy materials, but the Authors have been surprised to find that good results can be obtained with high-alloy materials. The percentage accuracy in determination of an element is much the same whatever the content of the element, but it follows that at high-alloy contents, the tolerance is higher. Since the proportions of alloy elements at the higher levels are usually not very critical, the tolerance is perfectly satisfactory. The figures below show the results which are being achieved.

It will be seen from the above that the spectrograph can be applied to the analysis of practically every type of cast iron, including low-alloy irons and high-alloy irons of the austenitic and 33 per cent. chromium types. The element showing the greatest variation of all those mentioned above is silicon, and the Authors have found it necessary to

Element.	Percentage range of occurrence.	Percentage tolerance.*
Low-alloy Irons:		
Silicon	0.5 to 3.5	±0.10
Manganese	0.3 to 1.5	±0.04
Nickel	0.2 to 3.5	±0.06
Chromium	0.05 to 2.0	±0.03
Molybdenum	0.2 to 1.0	±0.02
High-alloy Irons:		
Silicon	4.0 to 6.0	±0.15
Copper	6.0 to 7.5	±0.2
Nickel	12.0 to 24.0	±0.5
Chromium	12.0 to 22.0	±0.5
Chromium	28.0 to 34.0	±1.0

* The tolerance values are expressed at the mean point of the range.

adopt certain techniques for dealing with this element, which are described below. It would probably not be unfair to claim that, while spectrographic analysis in general does not give quite such an accurate figure as chemical analysis can do when the latter is performed under conditions of ample time permitting individual attention, it is more consistently accurate in routine analysis, as it eliminates many of the human sources of error inherent in chemical analysis.

To obtain the best results it is desirable to use chill-cast specimens. The Authors found that the size of specimen suggested by Hurst and Riley[2] was too large for many of their irons which are high in silicon to be effectively chilled. They have, therefore adopted a specimen ⅜ in. square

* Paper presented at the Buxton Conference of the Institute of British Foundrymen (title abridged). The Authors are, respectively, chief chemist and chief metallurgist, Sheepbridge Stokes, Limited, Chesterfield.

TABLE I.—*Comparison of Determinations by Spectrographic and by Chemical Methods.*

Material.	Result per cent. from spectrographic analysis.					Result per cent. from chemical analysis.				
	Si.	Mn.	Ni.	Cr.	Mo.	Si.	Mn.	Ni.	Cr.	Mo.
Low-alloy, centrifugally cast.										
4K6 (1)	2.52	1.04	—	0.44	—	2.55	1.04	—	0.43	—
(2)	2.36	0.86	—	0.31	—	2.38	0.84	—	0.33	—
(3)	2.31	0.88	—	0.35	—	2.30	0.88	—	0.36	—
(4)	2.70	1.04	—	0.39	—	2.68	1.01	—	0.39	—
D.T.D. 233 (1) ..	2.51	0.96	—	0.36	0.63	2.55	0.91	—	0.34	0.65
(2) ..	2.32	—	—	0.30	0.61	2.40	—	—	0.31	0.60
D.T.D. 485 (1) ..	2.50	0.95	—	1.01	1.02	2.57	0.93	—	1.03	0.97
(2) ..	2.54	—	—	0.96	0.98	2.48	—	—	0.94	0.95
Low-alloy, sand cast.										
Mark I (1)	1.44	1.18	—	0.13	—	1.44	1.21	—	0.14	—
(2)	1.23	0.91	0.28	0.09	—	1.22	0.94	0.28	0.09	—
Mark III	—	1.62	1.09	0.48	—	—	1.04	1.06	0.45	—
S.B.D.	1.68	1.19	1.83	0.50	0.23	1.59	1.25	1.80	0.49	0.23
Acicular	2.10	—	4.68	0.19	0.84	2.08	—	4.82	0.19	0.80
Ni-Hard	0.76	—	3.30	2.09	—	0.76	—	3.37	2.12	—
High-alloy irons.										
Enduron (1)	1.93	—	—	17.55	—	1.88	—	—	17.28	—
(2)	1.56	—	—	14.10	—	1.64	—	—	13.60	—
(3)	2.41	—	—	17.75	—	2.33	—	—	18.25	—
(4)	2.20	—	—	17.50	—	2.31	—	—	17.88	—
					Cu.					Cu.
Ni-Resist (1)	1.98	—	14.75	2.11	7.09	1.90	—	14.57	2.19	7.17
(2)	1.82	—	15.30	1.97	6.64	1.85	—	15.00	1.94	6.79
(3)	1.63	—	15.35	2.26	6.63	1.69	—	15.05	2.25	6.76
(4)	2.14	—	14.15	1.72	6.62	2.06	—	14.36	1.78	6.61
Nicrosilal (1)	5.05	—	22.10	2.63	—	4.99	—	22.15	2.66	—
(2)	4.07	—	21.50	2.55	—	3.95	—	21.15	2.47	—
(3)	3.90	—	20.08	2.14	—	3.78	—	20.15	2.21	—
33 per cent. chrome ..	—	—	—	32.40	—	—	—	—	33.27	—

by $1\frac{1}{2}$ in. long, which is cast in a split iron mould provided with a small tapered feeding head. A sand-cast grey-iron specimen, capable of being drilled for the analysis of carbon, sulphur and phosphorus, is also normally required. In order to avoid the trouble of casting this separately, the practice has been adopted of preparing a composite sample by placing a core-sand mould on top of the cast-iron mould, which serves the double purpose of directing the flow of iron into the small mould, and of providing a sand-cast bar suitable for drilling. Although the chill-cast sample is preferred, very useful results can be obtained from ordinary grey-iron samples, and it has been found possible to perform analysis of pig-irons by cutting out suitable lumps. The technique employed and the results obtained are described in the detailed section below.

Layout of Equipment

Among the points determining the suitability of the method for application in any given foundry are the space available and the working conditions. For the application now being described, use was made of a medium-sized laboratory room which was divided into three smaller rooms, as indicated in Fig. 1. This arrangement is not necessarily ideal, but was dictated by the space available. The spectrograph itself in the one room is the Hilger large quartz spectrograph, provided with a fixed slit 2 mm. by 0.015 mm., together with the standard Hilger sparking equipment, which includes a $\frac{1}{4}$-kv. transformer and condenser, and also a resistance box for the low-voltage d.c. arc. In the photometer room are located the Hilger non-recording microphotometer with galvoscale projector and the Judd Lewis comparator. The dark-room fittings are normal.

The secret of success in routine spectrographic analysis lies in the standardisation of working conditions, and this must be considered in planning the laboratory arrangement. Temperature control is usually regarded as a necessity, particularly in the dark room, as the development process is

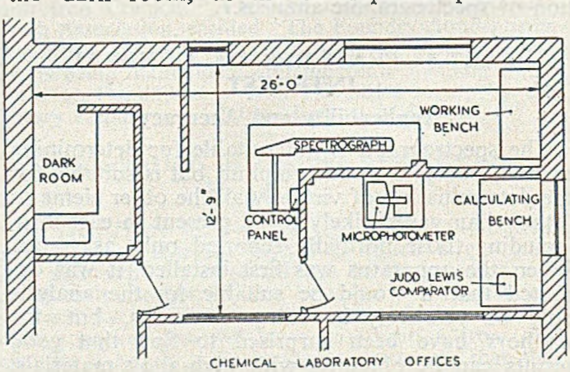

FIG. 1.—*Plan of Laboratory for Spectrographic Analysis.*

greatly influenced by temperature. The three rooms are fitted with wall heaters connected to a thermostat located in the dark room, the temperature control being, therefore, most accurate in the dark room. The rooms shown in Fig. 1 are located at the south-west end of the laboratory, have a flat roof, and are exposed to full sunlight in summertime. The difficulty in temperature control is not so much to heat up the laboratory in winter as to cool it down in summer. For this reason, the control temperature was fixed at 70 deg. F., which is slightly higher than normal, but which renders the problem a little easier. The ideal solution would be to install an air-conditioning system incorporating cooling arrangements for use in summer, but this was regarded as unjustifiably expensive. The solution ultimately adopted was to provide the laboratory with a false ceiling about 18 in. lower than the normal roof (which was fortunately high), and to blow cold air, drawn from the shady east exterior of the building, into the interspace between the roof and the ceiling, allowing the air to filter into the room through a series of holes bored in the ceiling. It was hoped that this system would tend to keep the roof cold, and thus to reduce the considerable downwards radiation in the summer. Furthermore, by blowing in air rather than by sucking it through an exhaust fan, the whole spectrographic section is maintained at a slight positive pressure in relation to the adjacent chemical section, thereby reducing the tendency for fumes to leak from the latter into the former. This arrangement has not been unsatisfactory.

Organisation of Work

The analytical work to be handled divides itself into two main sections. One type of analysis is required on irons which are being melted continuously throughout the day and sometimes during the night as well. Here, continuous control is needed and adjustments are made from hour to hour. It is, therefore, important that the analytical results should be made available to the control metallurgist as soon as possible after the castings have been made, and some economy in operation must be sacrificed to obtain this speed. The other type of analysis covers the considerable number of batch melts of a wide variety of un-alloyed and alloy cast irons, for most of which there is only one melt on each particular day and for which the mixtures are altered only on a day-to-day basis. It is then possible to collect together a batch of different materials, and to carry through the sequence of analytical operations on the batch as a whole. To economise in plate costs, the plates employed are 2 in. wide, and it is found that on each of these at least a dozen samples can be analysed satisfactorily. It is obvious that the batch method enables analyses to be carried out with greater efficiency, but the speed with which the results become available is correspondingly reduced. Analysis of pig-irons and some other raw materials can also be carried out in batches. As a guide to the time involved, it may be stated that, in urgent cases, an analysis for silicon, manganese, nickel and chromium on a single sample can be carried out within 15 minutes of the receipt of the sample. Where three samples are being handled, the total time is usually 30 to 40 minutes, while a batch of 12 samples would require about 1¾ hrs. for the complete series of operations, including the initial preparation of the samples.

Cost

The major cost in spectrographic analysis is the initial outlay for the equipment. The installation described in this Paper cost a little under £2,000, including the provision of the special heating and ventilating arrangements and the alterations to the laboratory, such as the building of the internal partition walls. Materials and labour form a much smaller proportion of the cost of spectrographic analysis than they do of chemical analysis, but the capital cost of the apparatus needs to be spread over a large number of determinations.

The laboratory described is making between 4,000 and 5,000 determinations per month, nearly 75 per cent. of which are performed spectrographically. It has been found that, whereas the number of determinations per analyst per day on chemical work has been between 20 and 25, a figure of at least 60 determinations per analyst can easily be achieved on the spectrograph. Consequently, with the existing staff it has been possible to increase the number of determinations carried out in the laboratory by 25 per cent., even while members of the laboratory staff were being trained in the use of the new equipment.

It is clear from the foregoing that the method is applicable only to relatively large laboratories carrying out a considerable number of determinations. Although the method has been found to be more versatile than was first expected, it is desirable for the instrument to be fed with a steady stream of work of the same type if the best results are to be achieved. It is ideally suited to the requirements of laboratories handling mass-production runs of iron requiring close control and frequent checks of composition.

In itself, the manipulation of the apparatus is very simple and does not call for a high degree of intelligence. With the provision of skilled supervision it should be possible to utilise unskilled labour without chemical knowledge after careful training. This method has not been followed in the present case, but use has been made of the existing laboratory staff of skilled analysts. The question of the psychology of the operators also needs consideration. To avoid boredom, it has been found desirable for one operator to carry through the whole of the operations himself, possibly aided by a second operator to attain greater speed at the measuring and recording stage. It is theoretically possible for one operator to spend the whole of his time exposing the plates and developing them, with two operators devoting their time to measuring and recording. Under such conditions, putting all emphasis on productivity, at least 500 individual determinations per day could be carried out, but again there would be a serious danger of fatigue and boredom amongst the operators, necessitating frequent changes of personnel.

It will also be found that this method of analysis seems to appeal much more to some workers than to others, and it is not unusual to find an operator who is skilled in chemical analysis but whose character is not suited to repetitive work, failing to attain the same standard of accuracy in spectrographic analysis, often because of minor errors in calculation, and, of course, the reverse may equally hold true. In the Authors' experience, female operators have proved extremely satisfactory and reliable.

Spectrographic Analysis

PART II—DETAILED ACCOUNT OF PROCEDURE

Preparation of Sample

The chill-cast specimen ⅝ in. square by 1½ in. long is first ground flat on two opposite faces and finished by polishing on a linisher with a 100 grit belt. The grinding and polishing are carried out in a separate room to avoid production of dust near the spectrographic apparatus.

Sparking Technique

The polished sample is placed face downwards on a Petri-type spark stand and a pure graphite electrode with a freshly sharpened 80 deg. conical point is clipped in the bottom electrode holder and the gap set at 2 mm., using an optical projection gauge. After a pre-sparking period of 15 seconds the shutter is raised and exposure commenced. On Ilford ordinary plates, exposure time is 40 seconds, while on Kodak B-10 plates, working with superimposed spectra, the individual exposures are of 20 seconds. This is controlled by a semi-automatic time switch, and the shutter is actuated by a solenoid. By this means, a high degree of standardisation of conditions is attained. The slit of the spectrograph is fixed at 2 mm. by 0.015 mm., and has attached to it a neutral-density filter giving two steps of 100 and 70 per cent. transmission, respectively.

Originally, a single-spot method of sparking was used and duplicate exposures were made on each sample, the analysis being reported as the mean of the duplicates. It was occasionally found, however, that duplicate estimations on the same sample night give silicon values differing by as much as 0.3 per cent. This appeared to be due to slight heterogeneity in the sample, since further exposures at the same points produced the same results. The use of a multi-spot spark technique resulted in improved reproducibility and is now the standard method, in spite of the consequent slight increase in time. Duplicate exposures are still made on each sample but each single exposure consists of two superimposed sparks taken at different portions of the sample's surface. Thus, on any given sample, exposures are made at four different locations, reducing the effects of heterogeneity.

Photographing Processing Technique

The composition of the developer is as follows:—[4]

Metol	10 gm.
Hydroquinone	22 gm.
Sodium sulphite (crystalline)	260 gm.
Sodium carbonate (crystalline)	180 gm.
Potassium bromide	3 gm.
Water to	10 litres

The developer is filtered into a storage bottle and a thin film of liquid paraffin is poured on the surface to prevent oxidation. The hardening fixer used is:—

Hypo	1,134 gm.
Sodium sulphite	75 gm.
Acetic acid (glacial)	47 gm.
Potash alum	75 gm.
Water to	5 litres

The plates are developed for two minutes with continuous non-rhythmic agitation in 100 ml. of developer contained in a stainless-steel developing dish 11 in. by 3 in. by 1 in. They are then rinsed in water and fixed in 100 ml. of fixing solution for a period varying from two minutes to ten minutes, according to the type of plate. Washing is carried out for five minutes under a stream of water, after which the plates are carefully wiped down with a soft chamois leather and dried rapidly in a blast of warm air from an electric hair dryer.

Plate Calibration

Considerable attention was given to the question of plate calibration, since a number of methods were available at the time the spectrograph was installed. The most widely used method was the intensity calibration procedure, in which the densities of the lines were related to their relative intensities. This procedure necessitates re-calibration when new developer is made up and when a new batch of plates is used—it is advisable, in fact, to check the calibration curve from plate to plate, since individual plates from the same batch may

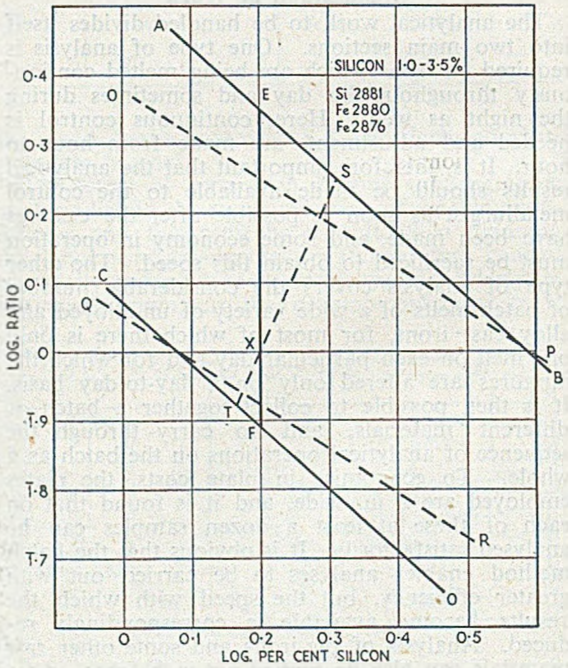

FIG. 2.—*Typical Graph for Spectrographic Determination of Silicon.*

vary, apart from the possibility of plates being mixed. The calibration work involved is considerable, particularly if the irons being analysed vary widely in composition, necessitating a large number of graphs for different materials. A new method was devised by Sanders[5] and adapted by Argyle & Price[3] for work with cast iron. This method depends on the correction for varying contrast from one plate to another by the simultaneous change of slope of two graph lines. For each estimation, the element line is measured and also two iron lines, one iron line having a density greater than that of the element line and the other a density lower than that of the element line. Both log ratios are calculated and the values obtained are joined by means of a straight edge, as shown on Fig. 2.

This figure shows the graph used for the estimation of Si in the range 1.0 to 3.5 per cent. AB and CD are straight and parallel graph lines obtained by plotting log ratios of Si 2881/Fe 2880 and Si 2881/Fe 2876, respectively, against log per cent. Si for a suitable range of standards.

E and F represent the log ratios for a sample exposed on the same plate as the standards from which the graph was constructed and the straight line between these points cuts the log zero axis at X. If the same sample and standards are exposed on a second plate of different contrast and the graph again plotted, it is found that the change in contrast causes a rotation, about the log zero axis, of the graph lines to the new position OP and QR. The new log ratios S and T for the test sample cut the concentration axis at the same point X, whether plotted on the first graph lines or the second. Argyle and Price[3] have shown that, provided the element and iron lines are not far apart and the densities of these lines all lie on the straight line portion of the plate-characteristic curve, the above method of plate calibration completely corrects for gamma variations across a single plate or from one plate to another. The correction is valid even for widely differing emulsions. In constructing these curves, the initial calibration is quite straightforward. The appropriate range of standards is sparked, processed and measured, and the log ratios obtained are plotted against the known analyses (obtained as the mean of a number of carefully performed wet determinations, preferably by independent laboratories).

Low Concentrations

In some cases it may not be possible to work on the straight-line portion of the plate-characteristic curve, and at low element concentrations it is usual to plot log ratio against concentration. Two curves are obtained for each element and interpolation between them gives a weighted mean which closely approaches the correct result. Concentrations approaching zero can be estimated by using an adjacent background reading and one iron line, in place of the usual two iron lines. It is sometimes difficult to find two iron lines of suitable density sufficiently near the element line, and the use of a neutral density filter is then of considerable assistance, as it is often possible to use the filtered and unfiltered portions of a single iron line in conjunction with the analysis line.

One great advantage of the method described is that the graphs, once constructed, require no alteration and can be used indefinitely, unless there is some fundamental change in the alignment of the spectrograph (*e.g.*, change of neutral-density filter), or in the means of excitation of the sample. No re-calibration is required on changing over to fresh developer, or to a new batch of plates. It is advisable, however, to run through appropriate standard samples periodically, to ensure that there is no lateral shift in the graphs. Such shifts do occur occasionally, and although the amount of shift is usually slight, it is desirable to observe and correct any such tendency.

Using this method of calibration, rigid standardisation of plate processing is not so critical, and slight variations in temperature of developer, development time and amount of agitation, do not affect the results. Thus, although a standard routine in plate processing is adhered to, variations in this routine, through accident or carelessness, have little or no effect on the final result.

Accuracy

The tolerances quoted in Part I of the Paper were obtained by determination of the standard deviation using the range-method on results furnished by duplicate determinations on some 30 to 50 samples, the tolerances being twice the standard deviation. The use of duplicate routine estimations is preferable to making a large number of determinations on a single sample, as it reflects working conditions better and also because, in the latter case, the operator may be subconsciously influenced by knowledge of the preceding values. Reproducibility tests have also been carried out, using the single-sample method. For silicon and nickel, 18 successive determinations on one particular sample containing 1.6 per cent. silicon and 1.26 per cent. nickel, gave a tolerance of ± 0.08 per cent. for silicon and ± 0.05 per cent. for nickel.

Routine Analysis of High-alloy Irons

The spectrographic analysis of the minor constituents in these materials does not present any great difficulty, provided that graphs are constructed for each alloy being analysed. As in the analysis of the low-alloy irons, the internal standard (iron) must remain reasonably constant, and the major alloying elements should not vary by more than the normal ± 2 per cent.

For rapid and accurate control analysis of high-alloy materials, it is, therefore, necessary to obtain a reasonably accurate estimation of the major constituents as soon as possible, as any large variation in the latter will cause proportional errors in the minor constituents. In recent years, several workers (*e.g.*, Shirley and Elliott[6]) have reported that it is feasible to analyse spectrographically high-alloy steels with a sufficient degree of accuracy for control purposes, and for this reason it was decided to attempt the estimation of the major constituents in high-alloy irons such as Enduron, Nicrosilal and Ni-Resist.

The procedure is identical with that used for low-alloy irons and it has been found possible by a suitable choice of lines to use the same exposure time, thus simplifying the standardisation of analytical procedure throughout the spectrographic work. In the study of a range of high-alloy concentrations, *e.g.*, of chromium from 12.0 to 24.0 per cent., it is desirable to utilise two iron lines, one of which is equal in density to the chromium line at about 12.0 per cent., and the other at about 24.0 per cent. This procedure, in which the density of the chosen element line is matched by that of one iron line at the top-end and by the second

Spectrographic Analysis

iron line at the bottom-end of the concentration range, should always be employed when the concentration range is wide. From the results given in the first section of this Paper, it will be seen that at concentrations of about 15.0 per cent. of chromium, the accuracy obtainable is of the order of ±0.5 per cent. In cases where the estimated concentration of the major alloy constituent falls near the limit of the specification, a chemical check is carried out to ascertain the exact content.

Analysis of Pig Irons

Although most of the recent work on the spectrographic analysis of cast iron has been based on the use of chill-cast test-pieces, it will be remembered that Ling, McPheat and Arnott[1] used grey-iron specimens with reasonably satisfactory results. Attention was, therefore, paid to the possibility of utilising the spectrographic method for the analysis of pig-iron, particularly as the checking of such incoming raw materials was an important item in the work of the laboratory. Samples were prepared simply by cutting pieces from individual pigs by means of an abrasive slitting wheel. The samples so obtained were ground in the same way as the chill-cast specimens.

The first experiments were directed towards the checking of the pig-irons for nickel and chromium, which are liable to appear as contaminating elements. The results obtained, in comparison with chemical analysis, were sufficiently promising to justify further work on other elements. In the first place, the estimation of silicon was attempted, using graphs prepared in the ordinary way on chill-cast standards, but it was found that low results were obtained, though the results were always low by a given amount at any one silicon level. A set of standards of grey iron was prepared, covering the range from 1.4 to 3.5 per cent. silicon, and consisting of a variety of pig-irons and pieces from castings. No attempt was made to standardise these samples, the only common property being that they were free from carbides.

It was found that, using the normal technique, a satisfactory silicon graph was obtained from these grey-iron standards, the only difference between the fresh graphs and the original ones being a lateral displacement of the index values to a higher silicon level. It follows from this that, while the spectrograph can be applied satisfactorily to grey-iron samples, it is essential that a fresh set of graphs should be prepared, and that work on chill castings must be kept quite distinct from that on grey-iron samples.

In analysing a truck of pig-iron, four samples are taken, a small piece being cut from each pig for sparking. A single spectrum, consisting of two superimposed sparks, is recorded for each of the four samples, the mean of the four silicon values being reported. In the range 1.5 to 3.0 per cent. silicon, the four values should lie within a spread of 0.2 per cent. of silicon, while in the range above 3.0 per cent., agreement is expected within 0.3 per cent. silicon. In cases where the above tolerances are exceeded, a chemical check is called for. The following typical results show the degree of agreement which can be expected between spectrographic and chemical analysis on pig-irons and grey irons:—

Material.	Silicon per cent.	
	Spectrographic.	Chemical.
Hematite pig (1)	2.23	2.24
Hematite pig (2)	2.99	2.99
Hematite pig (3)	2.99	3.04
Piston ring	2.38	2.46
Light casting	2.84	2.77
Centrifugal casting	2.47	2.37

In general, it may be said that although the agreement is not always as good as with chill-cast samples, it may nevertheless meet practical requirements. It may be objected that the heterogeneity of sand-cast pigs is too great for the method to be safe, but, in respect of silicon content, no troubles have been encountered. The following specific tests indicate analyses obtained at three positions on the cross section of some pigs.

Pig iron.	Silicon content per cent. at		
	Centre.	Shoulder.	Bottom.
Sheepbridge Foundry No. 3 ..	2.22	2.24	2.26
Goldendale	1.82	1.82	1.82
Millom	2.48	2.48	2.48

Special Applications

In addition to routine quantitative work, the spectrograph is used for qualitative or semi-quantitative analysis of a wide variety of metals and scrap. In many cases, this may be all that is required, but if more information is necessary, the preliminary spectrographic examination is an invaluable guide for subsequent chemical analysis. It is also extremely useful in carrying out analyses for elements which are normally present only in traces or very small quantities, and this tends to become more important in the higher-alloy and other specialised types of cast iron. Thus, tin may give rise to trouble in austenitic cast irons. In this case, spark spectra are insufficiently sensitive and a d.c. arc method of excitation is used. An accuracy of 10 per cent. is possible in estimating tin in the range 0.01 to 0.15 per cent.

In the production of spheroidal-graphite cast iron, the estimation of magnesium is of great importance, and before the development of a satisfactory chemical method, the spectrograph was calibrated for this determination using standard magnesium solutions. Several two-gram samples of magnesium-free iron were dissolved in a definite amount of aqua regia. Varying amounts of a standard magnesium solution were then added to each sample, representing concentrations of 0.01 to 0.2 per cent. The solutions were then filtered and made up to 100 ml. in a graduated flask. Three sets of two freshly-sharpened graphite electrodes were dipped in each solution and all were finally dried off in an oven at 110 deg. C. for 15 minutes. Using corresponding graphite rods as negative and positive electrodes, triplicate arc spectra for each sample were obtained under the following conditions:—

Exposure..	20 sec.
Arc gap ..	2 mm.
Current ..	3.4 amps.
Wave band	2,450 to 3,500 deg. A.
Plate	Ilford ordinary
Development	3 minutes at 70 deg. F.

A graph was constructed as previously described. By treating the test sample as above (omitting additions of magnesium solution) and taking the mean of the triplicate determinations, satisfactory results were obtained. Eventually, when a satisfactory chemical method had been developed, a range of solid standards was prepared for a fresh calibration, using the normal procedure of spark excitation. The two methods, when compared, showed reasonable agreement.

As already noted, one of the disadvantages of the spectrograph is its inability to determine carbon, sulphur and phosphorus. In some cases, it has been found possible to use other elements as an index of the proportion of phosphorus. In certain Derbyshire pig-irons of high phosphorus content, the titanium and vanadium contents are also high. If these pig-irons are being used in a mixture together with, say, Staffordshire pig-irons, which are of low titanium content, a close estimation of the phosphorus content of the cast iron can be obtained simply by determining the titanium and vanadium and applying a suitable factor. The method is unfortunately of limited application, as the West Coast hematites, for example, are low in phosphorus but relatively high in titanium.

Acknowledgments

This investigation was carried out in the laboratories of Sheepbridge Engineering, Limited, and the Authors wish to express their thanks to the directors for permission to publish the Paper. Before starting work, they had the benefit of personal discussions with each of the prior workers in the cast-iron field, and are especially pleased to acknowledge the help received from Dr. Riley and from Mr. Argyle.

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Discussion

Opening the discussion DR. R. V. RILEY was very pleased that Mr. Hallett had point out the different outlooks of the metallurgist on the one hand and the chemist on the other. Foundrymen in general required a sound casting to specification; they were not normally worried whether the chemist was accurate to 0.01 per cent. or not. They wanted a result of the analysis of yesterday's metal. The spectrograph did make it possible to give it to them to-day, whereas the chemist promised it in the ordinary way for to-morrow. He felt it was rather unnecessary to include Table I in the Paper. Everyone had seen those comparisons before, and by now all should be sufficiently enlightened to know that the spectrograph did give results accurately.

The Authors had pointed out that in the estimation of magnesium in cast iron the spectrograph was well ahead of the chemist. They had been able to estimate magnesium in cast iron before the chemical method was available. That was of some interest and one might recall another similar instance. The spectrograph, or the spectroscope as it was then called, had a number of years ago discovered helium in the sun before chemical methods had discovered it on earth.

He noticed that the laboratory described was able to deal with four to five thousand determinations per month; could that number be increased with the available equipment and the present technique? He rather suspected it could be doubled.

Calibration and Accuracy

It was interesting to note that the Argyle and Price method of calibration was used. In his experience he found the method rather lengthy compared with other types of plate calibration. It was certainly a good method and if the laboratory could afford to spend rather more time on analysis, then there was a good reason for using it. He did not quite agree with the remarks on accuracy. There was in the Paper a suggestion that the best way of determining the tolerance was by working on samples analysed in duplicate, the statement being made that "an operator if working on one sample may be sub-consciously influenced by the knowledge of the preceding values." In reading off the figures on a microphotometer, however, one had certainly not any idea of the ultimate result until it was worked out. The chemist, he agreed, might be influenced by the knowledge of a previous result. The method of using the two-line pair method of comparison (Argyle Price method) obviously was the reason for the good accuracy claimed. He agreed that pig-iron could be analysed in the manner given in the Paper and to the tolerances given. The chill-cast sample was, however, best for maximum accuracy. The method of determining phosphorus by means of titanium was a very good idea. It was, of course, not of universal application. Apart from titanium, other residual elements might be used in that way. In fact, he would go a stage further and say it might be possible to make a deliberate addition to one iron for the purpose of obtaining the analysis of the mixture.

MR. RONNIE, dealing with the last question, believed it quite possible that if phosphorus was added as an alloy with some other element not likely to be in the iron, the concentration of that other element would serve as a good indication of the phosphorus content.

Capacity Understated

With regard to the number of analyses it was possible to carry out with the spectrograph in a day, the figures quoted definitely underestimated

Discussion—Spectrographic Analysis

the capacity of the spectrograph. Since the Paper was written there had been a considerable increase in the number of analyses a day. In the case of one female assistant there was an average for the past month of over 100 individual determinations a day; that he thought was rather good.

As to the question of the accuracy of the spectrographic procedure, he only partly agreed with Dr. Riley's remarks about the assistant being influenced by the preceding values. An operator could not get much idea while measuring the lines on the densitometer, but in plotting the values on the graph it might be that he could not make up his mind as to whether it was 1.75 or 1.76 and might plump for the lower value in reporting his results.

The Argyle-Price gamma correction procedure did involve the measurement of one additional line but that disadvantage was largely out-weighed by the advantage in reliability. He had mentioned in the Paper the fact that there was a possibility of a foreign plate occurring in the batch and in that case they might run into trouble with the intensity-density calibration, but the Argyle-Price procedure would take care of that. In addition there was the advantage in calibration work involved. He pointed out that since the spectrograph had been installed there had only been need to calibrate once, and the curves had remained more or less unaltered since the initial calibration. The only safeguard was to put on an odd two or three samples to cover the ranges of concentration involved, just to check that there was no shift in the calibration curves.

Sample Selection and Preparation

MR. E. O. LISSELL asked, in preparing the specimen for a magnesium determination would they prefer a chill-cast or a sand-cast specimen? When preparing a solution for the wet method was a chill-cast specimen or a grey specimen used. Still referring to the magnesium determination, how did the Authors prepare the material for solution?

MR. RONNIE said that in the case of estimation of magnesium in nodular- or spheroidal-graphite cast iron they definitely preferred the grey specimen. The slower cooling rate in that type of sample allowed the magnesium sulphide to be eliminated by flotation, whereas in the chill-cast sample there was some danger of the sulphide being trapped, leading to the possibility of high magnesium values. If care was taken in the sampling of the magnesium-treated iron, a chill-cast specimen could be poured, but it must not be taken from the surface of the ladle. Even then, the magnesium content of the chill-cast specimen tended to be 0.005 to 0.01 per cent. higher than that of the corresponding grey sample. For the solution method, again they used grey material. One point to which attention was directed was the use of the whole of the drilled sample, the reason being that originally there was some suggestion that nodules of graphite might contain slightly more magnesium than the base material, and for that reason they had drilled a 2-gm. specimen and had dissolved the whole of it in aqua regia and diluted to a suitable volume.

Need for Caution

MR. ARGYLE added his congratulations to those of Dr. Riley to the Authors for the excellence of the work which they had reported. It seemed that the agreement between the spectrographic and chemical results was amazing. He suggested that foundrymen should use a little caution when reading the results. His own experience indicated that everyone who wanted to use the spectroscope should avail himself of the facilities of the British Cast Iron Research Association and have some of his routine samples actually tested at the Association's laboratory. In quite a number of cases the results were rather staggering. There was often lack of agreement and in the majority of those cases the chemical results were wrong and he had found that foundry people were rather reluctant to admit their chemist was wrong. However, it did happen sometimes that the spectrographic result was wrong. In view of that he suggested that a foundryman could not judge the value of spectrographic analysis for his own purposes from the results quoted by someone else. He did not wish to detract from the results of the work done by Mr. Ronnie and Mr. Hallett but to caution the foundryman before he went ahead with spectrographic analysis.

Applicability

On page 1 of the preprint the Authors had said that the spectrograph was not suitable for the determination of carbon, phosphorus and sulphur. That was enough to put any foundryman off, but he thought it should be added that carbon was already estimated spectroscopically quite well up to 0.9 per cent. in steel. The spectrographic analysis of phosphorus in steels was successful in America, while sulphur in ferrous materials was already spectrographically estimated in Russia. He thought there was reason to believe that in the future estimations of carbon, phosphorus and sulphur would be effected by spectrographic analysis using the instrument which the Authors had used.

He felt the Authors had not stressed the importance and necessity for close similarity between standards and test samples. They had mentioned it in passing, but it was a most important factor affecting the accuracy of spectroscopic analysis. He would like to know if the results quoted in Table I were representative of all the results which had been obtained spectrographically. It seemed to him that they were of the type of result which could only be obtained by highly-skilled workers, and the Authors had stated later in the Paper that they had not used unskilled chemists for that spectroscopic work. The figures at which he expressed amazement were the copper figures for the Ni-Resist material. It was contrary to experience at the Research Association that copper could give such excellent agreement with chemical results and also that silicon was not a very good element to determine spectrographically. They had found copper results bad and silicon results very good.

One other suggestion he had to make was that in Part II the Paper would be improved considerably if there had been included a list of the wave-lengths which had been used for the samples illustrated in Table I. That would be of considerable interest to the so-called specialist workers.

MR RONNIE said there was one thing he would like to do which he had omitted previously and that was to thank Mr. Argyle and Dr. Riley for the great assistance they had rendered in the installation of the spectrograph. Secondly, he confirmed Mr. Argyle's views about the desirability of securing the co-operation of the B.C.I.R.A. He had rather anticipated a question on the estimation of carbon, phosphorus and sulphur, and agreed that such estimations had been carried out spectroscopically. He believed some people in this country were estimating carbon in steels. Phosphorus was being estimated with the direct-reading equipment in America, for that type of equipment was more suitable for that determination, due to the lack of photographic sensitivity. Sulphur he did not know a great deal about, but believed he had seen it mentioned as having been done, but he could not give any details.

On the point about similarity between sample and standard they had more or less followed the procedure in the analysis of alloy steels. They used the same range of standards up to an alloy content of approximately five per cent. and they found the results quite consistent for a range of materials. In the case of the higher-alloy materials they had to prepare a separate set of standards for each material.

Accuracy of Silicon and Copper

As to the accuracy of the results for silicon and copper; silicon they had found did give rise to some variation. That might be mainly due to the heterogeneity of the sample and they were inclined to that view. Mr. Argyle's samples were probably prepared under better conditions than their own. In the estimation of copper there had been much difficulty in getting a suitable line. The two most sensitive lines, 3247 and 3274 were much too dense for the normal concentrations and exposures, so they had to make a separate exposure for copper using another wave-band setting. The line which they chose was not too suitable, being partially obscured by a diffused band superimposed on the copper line. The line itself did not appear until there was a concentration of about two or three per cent., but they found that at the concentrations usual in austenitic iron—six to seven per cent.—the results were quite satisfactory and in agreement with the tolerance quoted at the beginning of the Paper.

Referring to the accuracy of the tables, later on in the Paper it was stated that the table on the first page had been obtained by reproducibility tests on single samples in one case, but in the main they were calculated from the standard deviation values obtained from duplicate routine estimations. In the following table on page 2 of the preprint, the first set of results (the lower alloy materials) were results which were submitted to the A.I.D. for approval of the spectrographic procedure. The samples were taken at random on melts of A.I.D. materials and the results were checked carefully by normal chemical methods. The figures given in the higher-alloy materials could be vouched for. In preparing data for the Paper, they took the first batch of those materials which came along. Having been analysed in the routine way on the spectrograph, the samples were then submitted to wet examination and the wet analysis was carried out rather more carefully than usual. The chemical estimations in some instances had to be checked once or twice before they were sure of the final contents.

Written Reply

In further reply to Mr. Argyle the Authors wrote that they were glad to supply the list of lines which they had found most useful and this was given in detail as follow:—

DETAILS OF LINES USED.

Low-alloy Irons.

Element.	Range per cent.	Lines used. Element.	Lines used. Iron.
Silicon	1.0—3.5	2881	2880 2876
Manganese	0.3—1.7	2933	2937 2926
Nickel	0.2—1.0	3414	3413
Nickel	1.0—3.0	3101	3100
Chromium	Up to 2.2	2822	2823
Molybdenum ..	0.15—0.5	2816	2813
Molybdenum ..	0.5—1.3	2816	2813 2812

Highly-alloyed Irons.

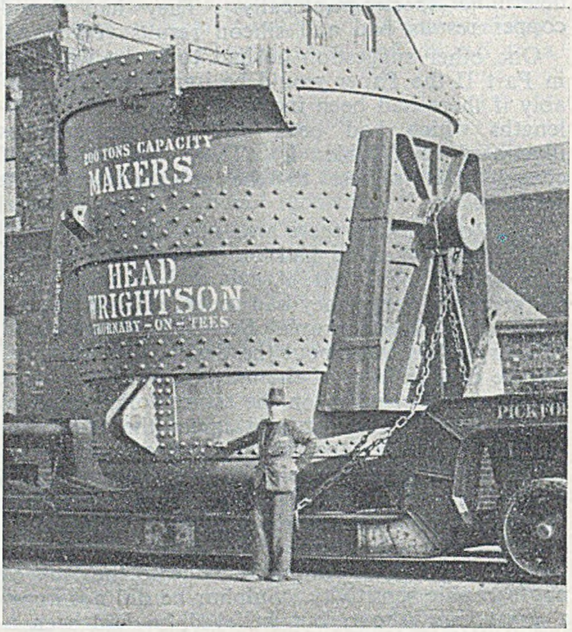
Alloy	Element.	Range per cent.	Lines used. Element	Lines used. Iron.
Silal ..	Silicon ..	4—7	2881	2880 2874
Enduron ..	Silicon ..	1.0—3.0	2881	2884
	Chromium ..	14—20	3022	3021.1 3020.6
Ni-Resist ..	Silicon ..	1.0—3.0	2881	2880
	Nickel ..	12—16	3054	3059 3075
	Chromium ..	1.0—3.0	2822	2831
	Copper ..	6—8	2369	2370
Nicrosilal ..	Silicon ..	4—6	2881	2880
	Nickel ..	19—24	3054	3059 3075
	Chromium ..	1.5—3.0	2822	2823 2831

The above lines were used in conjunction with a neutral density filter in order to cover the required range fairly closely.

Forty Years Ago. In the August, 1910, issue of the FOUNDRY TRADE JOURNAL an editorial commenting on the Annual Report of the British Foundrymen's Association (now the Institute of British Foundrymen) said if the progress [reported] was maintained the Association bid fair to wield considerable influence in the metallurgical world. The list of Papers to be given included amongst the authors the following famous names: Mr. R. Mason; Dr. T. Swindon; Mr. F. K. Knowles, B.Met.; Mr. R. Mather; Mr. G. A. Blume, of Sweden; Dr. W. H. Hatfield; Mr. W. S. Gifford, and Mr. O. F. Hudson. Truly a wonderful array, which would be difficult to match to-day. There was a description of a north-of-England foundry, which, even forty years ago, was not exactly an example of modernity. An article by R. Ardelt with typical German thoroughness, detailed the development of machines for ramming pipe moulds, culminating in a full description of his own contribution which achieved much success. In the commercial section, the registration of Petters, of Yeovil, as a limited company was announced.

200-ton Casting Ladle

What is believed to be the largest steel casting ladle in the world has been delivered by the Teesdale works of Head Wrightson & Company, Limited, to the Abbey Works of the Steel Company of Wales. This ladle (on right), one of an order for fourteen, has been built to carry 200 tons of molten steel. Its inside diameter is 13 ft. 6 in., its overall height is 14 ft. 6 in., and it weighs 50 tons. A special 240-h.p. Diamond "T" tractor with a 16-wheel trailer, provided by Pickfords Heavy Haulage Service of the Road Haulage Executive, carried the ladle during its 10-day journey, which required a great deal of planning in mapping a route for this monster to ensure its safe delivery. The ladles have been designed in the company's McKee division which has recently obtained a number of large contracts for the iron and steel industry, both in this country and abroad.

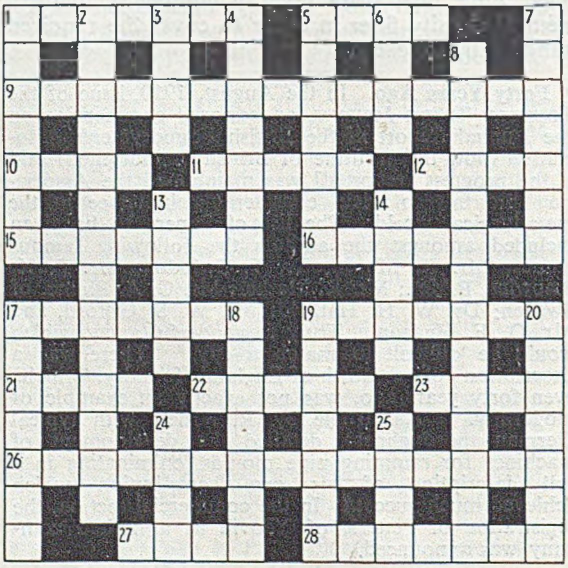


BETWEEN AUSTRIA AND BRAZIL, a trade agreement initialled in Rio de Janeiro recently, and to operate during the current year, provides for $1,000,000 worth of steel products to be supplied by Austria and $400,000 worth of iron ore to be supplied by Brazil.

CONSENT OF THE Minister of Fuel and Power has been received by the BEA to the development of the Roosecote power station, Barrow-in-Furness, to its full capacity. The station, when completed, will have a total installed capacity of 120,000 kW, made up of four turbo-alternator sets of 30,000 kW each.

F.T.J. Crossword Prize Puzzle

A prize of two guineas will be awarded to the sender of the first correct solution reaching us not later than the first post on August 17. Envelopes must be marked "Crossword Puzzle," and be addressed to the Editor. Each envelope must be franked with a 2½d. stamp. As many of our readers file their copies of the JOURNAL, redrawn puzzles or a list of the answers written out and numbered will be accepted.



Clues

ACROSS.

1. A busy place from which to get coke. (7)
5. Linseed substitute. (4)
9. They are pointless think TS 34. (Three words, 8, 3, 4.)
10. The artist goes back in the modulus of elasticity. (4)
11. A decoration goes to a compass point. (5)
12. You will grin if a cracked casting does. (4)
15. Without 23 across, an example of the founder's art. (7)
16. Each day a lighter job the cupola man. (7)

17, 22. When in trouble the steelmakers do. (Three words, 5, 2, 5.)

19. The "cause" of a wise man going round the States. (7)
21. Curiously enough, risers do! (4)
22. See 17 across. (5)
23. The Indian moulder's "elevenses." (4)
26. Watch circle line for a useful foundry machine. (Two words, 10 and 5.)
27. Undo this reef knot. (4)
28. Pods mixed with a Devon river show what a film suffered. (7)

DOWN.

1. They strike a jarring note. (7)
2. A true tile joint makes a bit of sand testing apparatus. (Two words, 11 and 3.)
3. Add a kiss to these letters for a finger. (4)
4. The metallurgical object of the Philosopher's Stone. (7)
5. A hygienic or bench moulder. (Two words, 3 and 4.)
6. Multiply in gross less tare, (4)
7. Where the foreman and the finished casting should be kept. (7)
8. Main six inch gem can make useful foundry plant. (two words, 6 and 8.)
13. Quite a good property in liquid metal. (5)
14. French nails—one of our best clues? (5)
17. War sets the rate of rejection. (7)
18. I separate animal and mixed dies and so does mill scale. (7)
19. Metallurgically stratified is that backward Inland Revenue in state. (7)
20. Electrical apparatus must be. (7)
24. At the cinema or in rumblers. (4)
25. Change this wasp. (4)

Steelworks Castings

By L. H. Williams, B.Sc., A.R.S.M.

The United Steel Companies, Limited, who had operated the war-time factory of The Distington Hematite Company, on the North-West Coast, purchased the premises in 1946, and converted it into an iron foundry for producing heavy steelworks castings, including ingot moulds and slag ladles, under the name of Distington Engineering Company. At about the same time, the iron foundry of the Workington Iron & Steel Company in the same area, which had previously made steelworks plant, was closed down and its skilled personnel were transferred to the Distington works.

THE DISTINGTON WORKS now produce ingot moulds, slag ladles, and general engineering castngs. The ingot moulds are used by many of the large steelmaking concerns in this country, including branches of the United Steel Companies, Limited, and are also exported.

General Layout

The works, which is sited near the sea, covers an area of 54 acres and the buildings occupy about 600,000 sq. ft. The main building houses under one roof a foundry, a press shop and machine shops. The former two lie alongside one another at the north of the main building while the machine shops are at the south end. This makes an overall length of some 1,280 ft. and a width of 380 ft.; of this 233,700 sq. ft. form the foundry proper.

Fig. 1 indicates the general layout of the foundry. Design and layout have been planned basically around the manufacture of ingot moulds by flow-production methods. There are two casting floors, one for heavy and the other for medium weight castings, and also some mechanical moulding.

Melting Facilities

There are four cupolas with a rated output of 20 tons per hr. and a fifth of 6 to 8 tons per hr. These have been installed by staff engineers, but are of conventional design, the large cupolas having a stack height of 25 ft. 6 in. and a hearth diameter of 6 ft. 6 in. They have two rows of 12 tuyeres, the upper row being fitted with dampers. All five furnaces are of the hydraulically operated drop-bottom type, and a track below facilitates the transport of the slag in bogies to the tip. Each cupola stack is fitted with a spark arrester.

The four large cupolas are served by three electric Rootes-type blowers made by W. C. Holmes & Company, Limited, each with a capacity of 13,500 cub. ft. per min. at 40 in. w.g. A fan-type blower with a maximum capacity of 4,500 cub. ft. per min. blast serves the small furnace. At present, the large cupolas are worked in pairs. The furnaces are tapped approximately three times per hour, depending on the rate of metal consumption in the casting bay.

The charge for the cupolas is held in the stock pits and bunkers in the bay behind the cupolas being replenished direct from standard wagons using the rail track running the full length of the foundry. Limestone and coke are fed by a bucket elevator from a pit below the rail track into the bunkers, while scrap metal and pig-iron are unloaded into separate stock pits by a magnetic grab. Charges are weighed directly into bell-bottom skips on a weigh-car and hoisted to the top of the cupola stack by one of two 6-ton Wellman cranes fitted with a jib. The release of the charge is effected by a " wish-bone " device which supports the top of the bucket on the furnace shaft while the bottom is lowered by the crane.

The four large cupolas are used entirely for the production of hematite iron for heavy castings, ladles and ingot moulds, while the smaller furnace supplies grey iron or low-alloy cast iron. In general, three hematite irons are made, all containing a minimum of 3.6 per cent. C, but with varying silicon content, including a high silicon iron (1.5-2.0 per cent. Si) used for moulds and ladles; a low silicon iron (1.0-1.5 per cent. Si), and a high-phosphorus iron (1.0-1.4 per cent. Si with 0.1-0.2 per cent. P).

Bottom pouring is generally practised for the heavy castings, using a 25-ton capacity ladle equipped with a plumbago nozzle, similar to that used in steelmaking practice. Over-the-lip ladles are used for the smaller castings and range from hand-manipulated ladles to those of 16 tons capacity. Teapot-type ladles are also used.

Slag-ladle Moulding and Casting

Slag ladles of a large variety of designs and sizes are cast, the work being almost entirely confined to bay No. 3 (Fig. 2). The ladle mould is built in brick in one of seven pits, a facing of loam consisting of 50 per cent. used and 50 per cent. new sand being supplied direct from the sand-mixing plant. The moulds are built around skeleton wooden patterns or strickles. The whole operation is done by skilled moulders. The cores are dried by gas, but new air and gas driers are being installed.

Split ladles are not infrequently made, both halves being cast simultaneously in one mould having splitting cores to ensure a good fit in the finished product. Although a solid ladle is cheaper, some foundries have insufficient handling capacity to make the moulds in one piece, while some customers

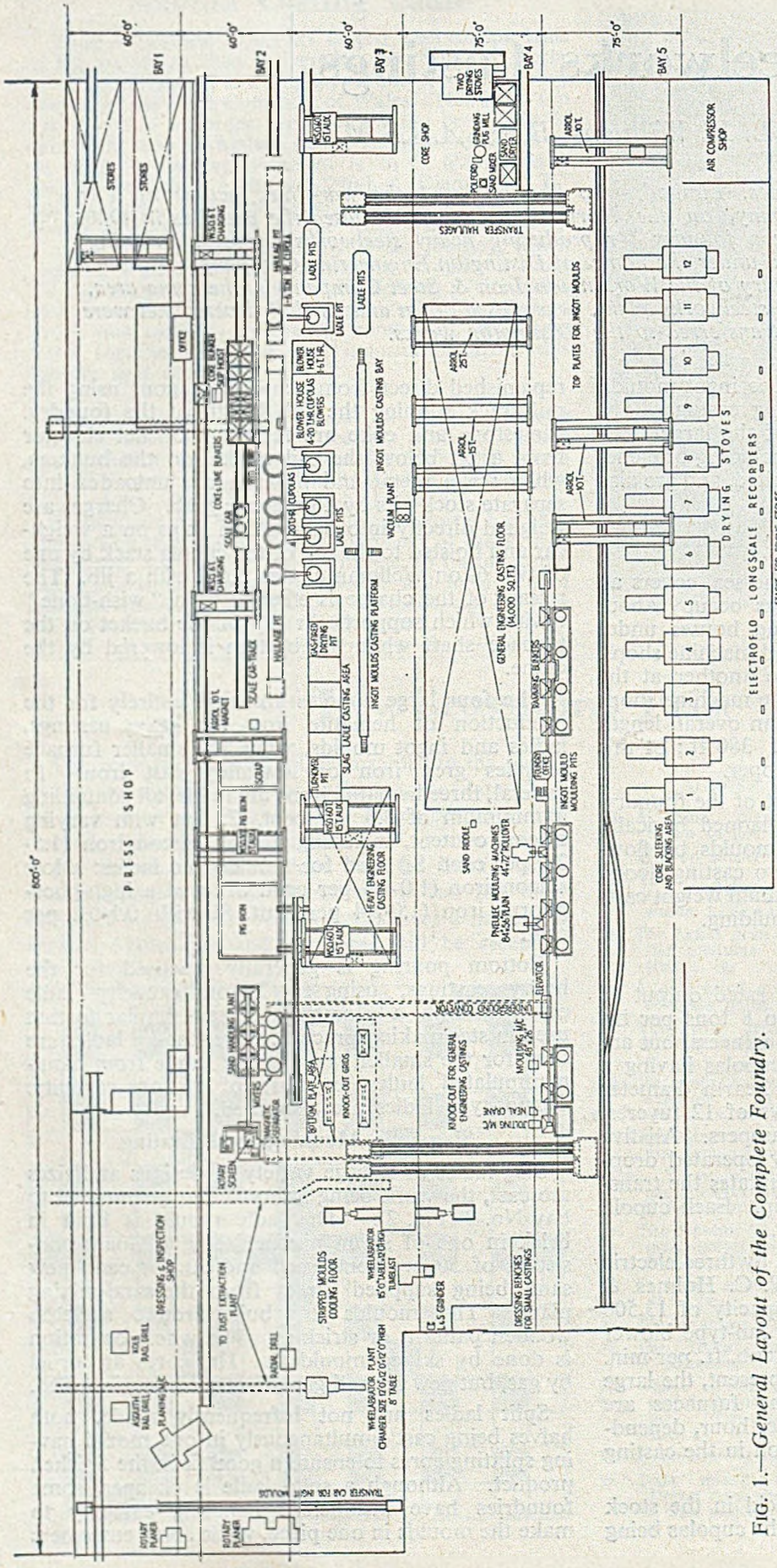


FIG. 1.—*General Layout of the Complete Foundry.*

claim that split ladles facilitate repair and maintenance. The ladle may be split either horizontally or vertically, the latter being the more usual.

The ladle cores are prepared in a manner similar to the preparation of moulds, either by pin and strickle-board technique if conical (Fig. 2) or a pattern former and skeleton is used (Fig. 3). A rough internal core of refractory brick interspaced with flat horizontal cast-iron discs is first built (Fig. 4) on which the true surface of the core is shaped with loam. Vertical lifting irons within the brick foundation are bolted to the discs so that the core can be inverted and lowered into the mould. Figs. 2 and 4 show first and final stages during the core manufacture of a Pollock ladle mould. After drying in a pit, the core is blacked, dried again, and inverted in a turnover pit. It is then lowered into the mould, which has also been dried. Uphill teeming is generally practised.

Ingot-mould Production

As in the case of ladle castings, a large variety of designs and sizes of ingot mould is manufactured, but the general methods used for each type are similar. Both core and body mould are prepared in the ramming pits in front of the drying stoves, each pit being equipped with a rotating platform at the bottom, automatically and continuously turned during moulding operations by a 3-h.p. motor. In the formation of the ingot-mould core, a cast-iron hollow core-barrel, perforated for venting, is first covered with a single winding of $\frac{1}{4}$-in. or $\frac{1}{2}$-in. dia. wood-wool rope from the bottom to the joint level, and is permanently bolted to a cast-iron drag plate. The rope binding assists venting and facilitates the drying and easy removal of the core barrel after the casting has been completed. A number of such cores ready

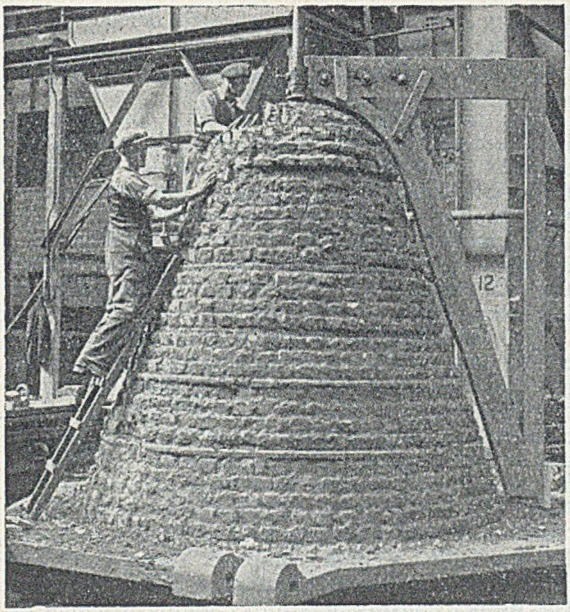


FIG. 2.—*First Stage of the Pin and Strickle Board Technique of preparing a Core for a Pollock-type Slag Ladle.*

for moulding are shown in Fig. 5. After the core-barrel base has been coated with loam and roughly strickled, the whole is lowered into one of the pits and a wooden core-box is placed over it, being located by dowel pins. The core-box is often faced with sheet aluminium to form a good surface, to facilitate release of the core, to retain accurate shape and to resist wear.

Ramming is then commenced while the core-box is slowly rotated on its turntable and mixed sand is automatically and continuously fed from a 7½-ton capacity hopper, shown diagrammatically in Fig. 6. As the sand is fed, the moulder manipulates a pneumatic hand-controlled rammer supported by an overhead jib. When completed, the outer casing is removed, the cores are sleeked and blacked, after which they are dried in the stoves over 11 hours, during which time they attain a temperature of 250 deg. C., which is retained for 3 to 4 hrs.

The mould is prepared in a similar way using a large cast-iron box constructed of one or more units fitted together according to size. The wooden pattern is faced with light-alloy sheet in the same way as the core-box. Ramming, blacking and drying are carried out as already described for core manufacture. The cores and mould require little finishing if rammed properly. All moulds are blacked in the green state so that they require no further treatment after drying.

Meanwhile the top plates are prepared, and when dried the mould components are conveyed to the casting bay by transfer haulage bogies and there assembled. The bottom plate or drag is attached to the barrel and is prepared before the core is rammed; it receives its finishing touches when the core is "sleeked." The closing of the mould on to the drag with accurate location by means of dowel pins, and the fitting of the top plate, is next done. Just before the top plate is clamped on, a light-alloy pipe, attached to a vacuum main running the full length of the casting bay, is lowered into the mould and all dust is completely removed.

Casting—Several methods of gating have been tried with varying success. Standard practice now in this foundry is to bottom run *via* a 3-in. dia. down-runner, and to employ four or more risers. Fig. 7 is a diagrammatic cross-section of the ingot-mould mould set-up.

Stripping and Fettling—As soon as the casting is solid, by which time the wood rope around the core-bar is burned, the clamps are removed and the core-barrel and drag are lowered and placed on the transfer bogie. The moulding box is then removed and returned *via* the transfer bogie to the ramming bay. The mould is left for two or three days until cold. At the end of this time, it is placed on a pneumatically operated bogie, which conveys it into the Wheelabrator chamber. A full history of each mould casting is supplied to the company's research department.

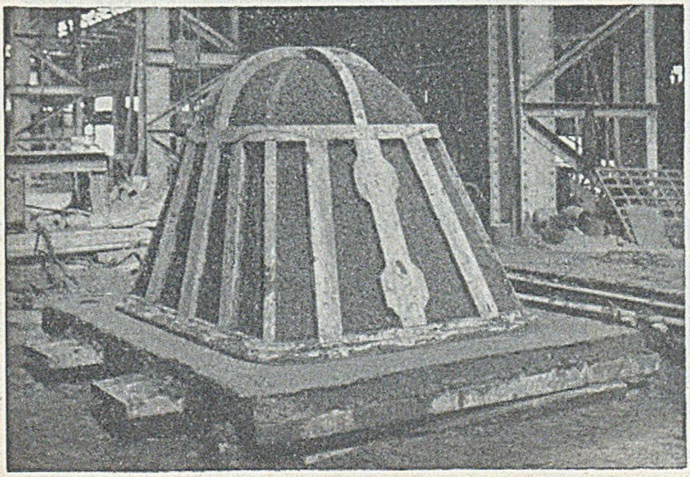


FIG. 3.—*Skeleton Pattern in Use to Form Core of Dewhurst-type Ladle.*

Ingot-mould Life

Ingot-mould life is one of the major problems and a progress recording system has long been in use, and it is now being developed to concentrate all the information in a single filing system. A constant check is made on all patterns for size and conditions. For their own purpose they can check at a glance the complete life history of any one mould from its manufacture to the time when it fails. Observations at all stages of moulding include physical properties of sand; grading; average hardness of core as measured by means of a Ridsdale hardometer—this can be correlated with the permeability and density by means of standardised graphs prepared within the laboratories; type of pattern whether metal or wood faced; barrel wrapping used; rammer's report; analysis of sand mix used; details of drying, including temperature and time; analysis of metal used and details of charge with analysis of individual components of the charge; details of teeming operations, including method of casting, time of casting and periods lapsing between casting and stripping; inspector's report before leaving final dressing shop and, finally, the steel-plant user's report up to the time of failure. From the latter's report the length of service, the number of castings made and rate of castings made are all-important facts. All these details are collected in the research department and it is proposed to transfer them now to the Hollerith electric filing system. From these records, correlation of mould life, ingot casting practice and foundry technique can be determined.

Contact by the research staff with the users places them in an excellent position to review the design of moulds, and the trend of results may be observed periodically by quick reference. Quality control curves are derived and a " defective index "—a measure of the magnitude of each defect—is calculated.

Other Foundry Sections

The southern end of the foundry comprises the knockout and dressing shops. Here the castings are stripped from their moulds and cleaned in one of three Wheelabrators, from which the sand is conveyed underground to the used-sand bunkers. The ingot-mould castings pass to a small machine shop installed within the precincts of the foundry, also at the south end, and finally pass to the dressing and inspection shop.

The general-engineering casting bay has its own core-drying stoves and core-preparation area at the north end of the foundry. Facing sand for all requirements in the foundry is also prepared in the core section, which has its own pug mill and grading unit. The complete ingot-mould mould preparation is concentrated in front of the drying stoves.

In addition to the facilities for ladle, ingot mould and floor moulding, four moulding machines are available. These comprise three Hermann Pneulec type and one Coleman moulding machine. The former consists of a direct jolting machine of 10,000-lb. capacity and two roll-over machines of 2,000- and 1,500-lb. capacity, respectively, while the latter is a roll-over machine taking up to 2 ft. sq. boxes. All machines are fitted with vibrators and are installed behind the ingot-mould moulding pits, being fed from special sand hoppers. The larger

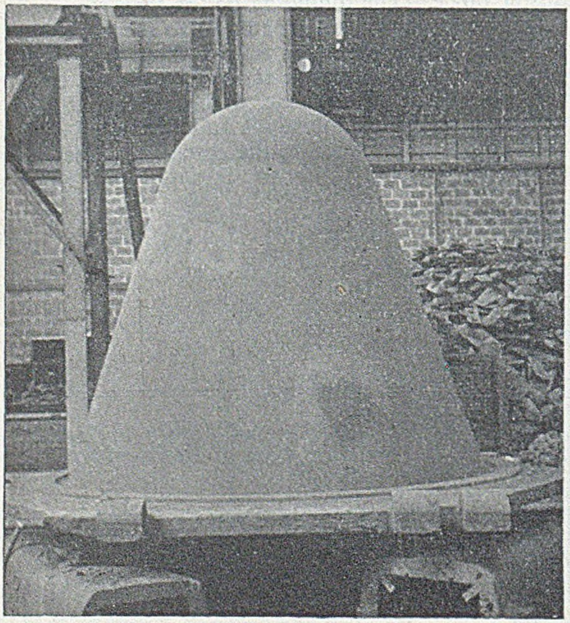


FIG. 4.—*Finished Core of Pollock-type Slag Ladle.*

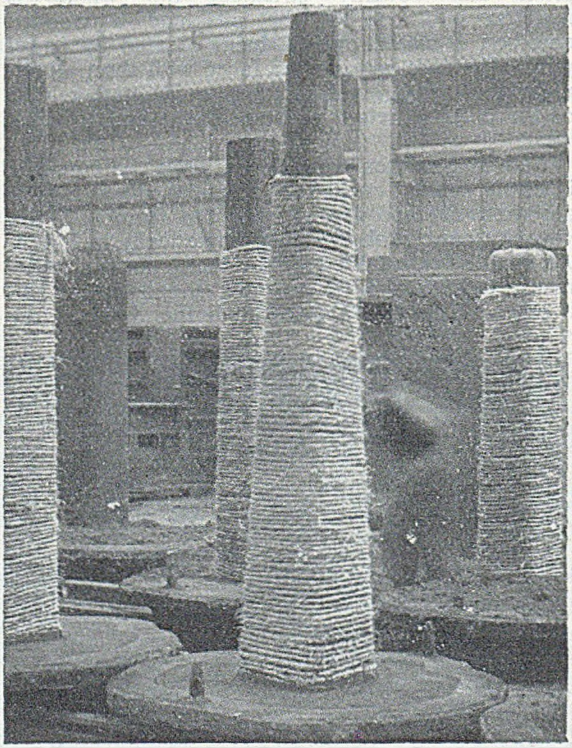


FIG. 5.—*Ingot-mould Core Barrels protected by Wood-wool Rope.*

machines can make moulds for bottom plates weighing up to 4 tons and cores for larger castings. The smaller machines are used either for the batch production of moulds and cores for small castings or for single moulds and cores for which this method of production is suitable.

Drying Stoves

The drying stoves consist of 12 modified heat-treatment furnaces previously used for annealing ingots, but now used for drying moulds and cores for ingot moulds and for the annealing of castings. All are coal fired, using Mirrlees auto-feed stokers, and pyrometrically controlled by a system specially designed by the Electroflo Meters Company, Limited, so that any variety of heating cycle may be followed. Hot products of combustion enter the heating chamber through four ports in the back wall from the two fire boxes attached to each stove. Coal is fed to each hearth from its own hopper by means of an Archimedean screw in the normal manner, the rate of feed being governed. Exit ports near the front lead the hot gases through flues enveloping the side walls of the stove to the exit main at the back and thence to stack. One stack to each pair of stoves is now fitted with a fan in its base to induce sufficient draught. The heating chambers are about 12 ft. 6 in. wide, 23 ft. long and 11 ft. 6 in. to the crown. Two core-drying stoves, also coal fired by Mirrlees stokers, are available in the core-preparation shop.

Sand-mixing Plant

The main sand-mixing plant, situated at the south end of the line of cupolas, supplies green sand to all the moulding sections. Used sand from the knockout grids arrives *via* a bucket elevator at one of the three bunkers, having been cleaned of any metal by magnetic separators and a rotary screen. Fines are removed by a suction unit. The used sand is mixed as required with new sand from the other bunkers in one of three August Simpson mills and for constancy of the product a close control of the moisture content is maintained by sampling every 30 min. Normally the moulding sand is mixed for at least 8 min. and contains 25 per cent. new and 75 per cent. old sand with about $7\frac{1}{2}$ per cent. moisture. Much experimental work is in progress under the control of the research laboratory and a careful record is kept of all the particulars of the sand mixes used.

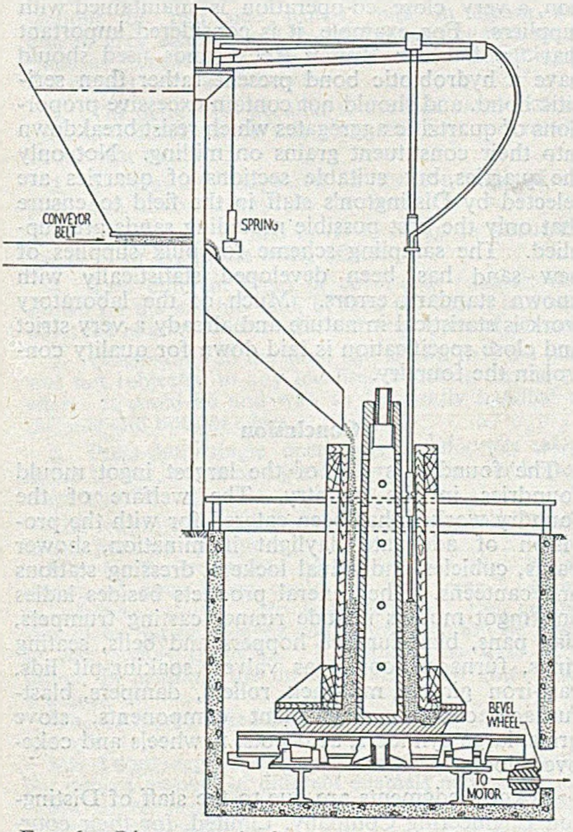


FIG. 6.—*Diagrammatic Cross-section of the Ingot-mould Core-ramming Operation.*

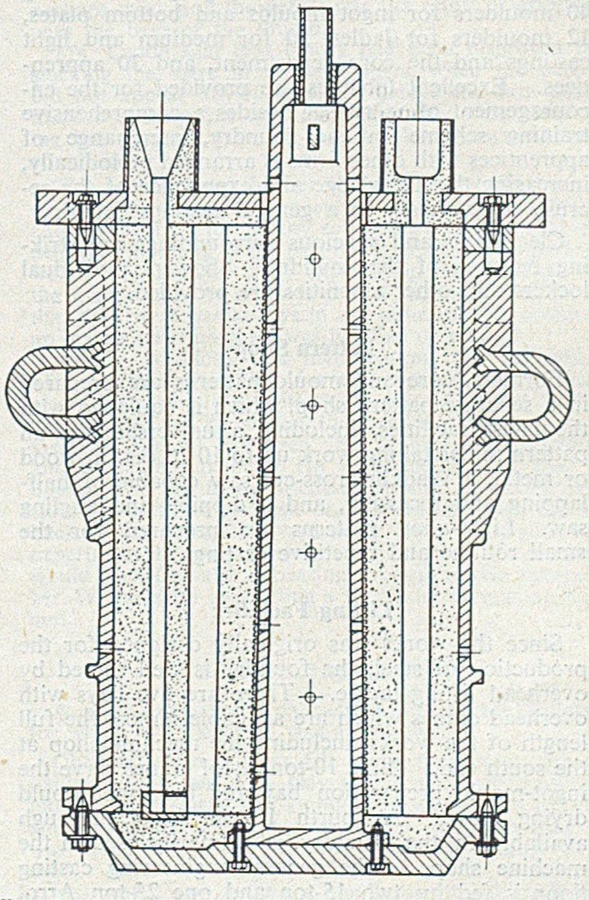


FIG. 7.—*Section through the Ingot-Mould Set-up Ready for Casting.*

The new sand is a mixture consisting of three parts Durham rock yellow sand and one part Abbey red sand, both of which arrive already graded under a strict specification laid down by the foundry. After the mix is prepared, a belt conveys it either to the heavy casting floor or underground to the other side of the foundry, where it is lifted in a bucket elevator to an overhead belt from which it is ploughed off into individual hoppers serving the moulding pits.

Besides the main preparation plant, Royer machines are available on the general engineering casting floor and a special unit supplies the facing and backing sand in the core department.

Output and Personnel

The foundry produces five to six ladles per week, but there is total moulding capacity for eight to 10 ladles. At the moment there is an overall output of 1,200 to 1,400 tons of iron castings per week, comprising—Ingot moulds and bottom plates, 1,000 to 1,200 tons; slag ladles and heavy loam moulded castings, 80 tons; general iron castings, 120 tons.

In all, about 300 men are employed, including 40 moulders for ingot moulds and bottom plates, 12 moulders for ladles, 50 for medium and light castings and the core department, and 30 apprentices. Excellent facilities are provided for the encouragement of recruits. Besides a comprehensive training scheme in the foundry, interchange of apprentices with other firms is arranged periodically, increasing the knowledge and experience of the recruit, so necessary in a general castings foundry.

Cleanliness and spacious surroundings are striking features of the foundry. Showers, individual lockers and other amenities are provided.

Pattern Shop

Formers, core and mould patterns are prepared in a separate pattern shop, which is equipped with the latest facilities, including a universal Wadkin pattern miller taking work up to 10 ft. dia. in wood or metal, a Wadkin cross-cut saw capable of half-lapping and recessing, and a dipping and angling saw. Light-alloy patterns are prepared for the small routine and repetitive castings.

Lifting Facilities

Since the works was originally designed for the production of steel, the foundry is well served by overhead lifting tackle. There are five bays with overhead cranes which are available almost the full length of the works, including the machine shop at the south end. Three 10-ton Arrol cranes serve the ingot-mould preparation bay and the ingot-mould drying stoves. A fourth 10-ton Arrol, although available in the foundry, is primarily used in the machine shop. The general engineering casting floor is fed by two 15-ton and one 25-ton Arrol cranes. These cranes are available for casting manipulations and knock-out operations. Three 60-ton Wellman Smith Owen cranes, each fitted with a 15-ton auxiliary hoist, are available in the main heavy casting bay in front of the cupola bay. These carry the bulk of the work in the foundry, including ladle, ingot mould, and heavy engineering (over 18 tons) castings, and convey the castings to the knock-out grids and cooling bays at the far end. Stock bins are served by a 10-ton magnet crane which transfers pig-iron and scrap to a scale car. A 30-ton Wellman crane with a 5-ton auxiliary is used for handling castings at the finishing end of the foundry.

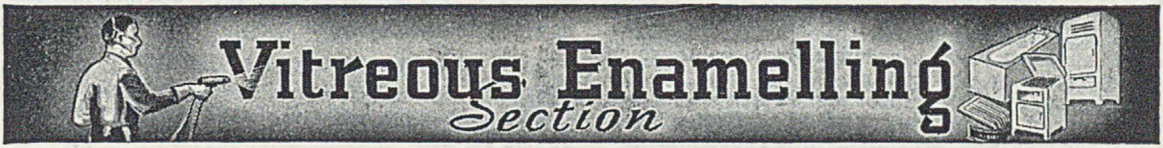
Research Department

The general description of the foundry would not be complete without special reference to the research department whose work is of importance to the foundry production with which a close liaison is maintained. The programme of work is comprehensive, involving mainly quality control and consumer research. Testing apparatus is available for general inspection of all moulding sand as it arrives. Grading is an important item, as bulk grinding plant has not been installed in the foundry and most of the material received should be ready for use. The moulding qualities are examined by the usual tests, including mechanical, refractory and permeability tests. Experimental work in mixes and various types of sand is always in progress; in this connection, a very close co-operation is maintained with suppliers. For example, it is considered important that the Durham Rotten Rock sands used should have a hydrobiotic bond present rather than sericitic bond, and should not contain excessive proportions of quartzitic aggregates which resist breakdown into their constituent grains on milling. Not only the quarries, but suitable sections of quarries are selected by Distington's staff in the field to ensure that only the best possible moulding sands are supplied. The sampling scheme for bulk supplies of new sand has been developed statistically with known standard errors. Much of the laboratory work is statistical in nature and already a very strict and close specification is laid down for quality control in the foundry.

Conclusion

The foundry is one of the largest ingot mould foundries in the country. The welfare of the foundry workers has been catered for with the provision of adequate daylight illumination, shower baths, cubicles, individual lockers, dressing stations and canteens. The general products besides ladles and ingot moulds include runner casting trumpets, slag pans, blast-furnace hoppers and bells, seating rings, furnace doors, gas valves, soaking-pit lids, cast-iron girders, mill-rack rollers, dampers, blast-furnace coolers, sinter-plant components, stove grids, large cylinders, acid pots, flywheels and coke-oven doors.

Acknowledgments are due to the staff of Distington Engineering Company, Limited, for their courtesy during the visit to their works and also for their co-operation in the preparation of the article.



Defects in Enamelling

As a basis for an open discussion on enamelling practice, members provided specimens of enamelled ware which showed various types of defects, some of relatively frequent occurrence and some only rarely encountered. Causes and cures which were put forward, as well as constructive criticism of methods of manufacture, provided much technical information of value to all enamellers.

THE SUBJECT FOR a meeting held at the conclusion of last session by the Midland section of the Institute of Vitreous Enamellers (Mr. J. Price presiding) was "Defects," and it was provisionally arranged that if necessary Mr. S. Hallsworth should give a short Paper on this subject. However, the response to an invitation to Members to bring or send along specimen "defects" was so good it was deemed wise to commence at once to deal with the varied problems brought forward.

"Crawling" Defect

The first sample to be submitted consisted of sections of two side panels, one in cream and one in grey enamel, and the defect was known to the trade as "crawling." The details submitted relating to the defects were as follow:—

1. The defect was peculiar to the side panel and had been in evidence since this plate was first processed—about two years.

2. It invariably appeared on the top edge of the plate and almost always in the front corner.

3. It appeared in first cover coat, up to about five per cent. of the pieces being affected.

4. Two different types of cover-coat enamels were shown on the exhibits and, in fact, the defect had been observed in about four or five different types of enamels.

5. Observation in the shop had shown that the plate was not subjected to any localised handling on the top edge. It could be and was, as frequently handled on the side and bottom edges.

6. Press-shop single operations on the job were: Shear to size; blank and pierce; form; turn over bottom edge; and frazing.

The reason suggested for the defect was local strains in the pressing operations.

MR. C. P. STONE was of the opinion that by no stretch of imagination could the "crawling" be due to pressing strains. He suggested that the enamel should be put on thinner and more attention be given to the biscuit strength. No doubt the base of a thumb in handling the unfired ware could cause such a defect.

MR. GRAINGER asked if the samples were of titanium enamels.

MR. LEGGE replied that one was a titanium enamel, but quite a number of different enamels had been tried.

MR. STONE then asked if the thickness of the enamel had been measured.

MR. LEGGE explained that the same defect was encountered with varying thicknesses of enamel. During the two years during which his firm had experienced the defect four or five different enamels had been used without any obvious variation, also, the same enamels had been used on different plates but the defect only appeared on the particular design now under observation.

MR. PARKES asked if the defect was repeated if the plate was de-enamelled and re-enamelled.

MR. LEGGE said that none had been so treated.

MR. STONE asked if operators handling the plates wore asbestos gloves; he thought the biscuit strength was perhaps weak and the defect was the result of gripping with the base of the thumb.

MR. LEGGE said that theory had been disproved by stacking the ware in different ways, when the defect did not appear anywhere else. Before the firm commenced making this type of panels, they were processing the previous type for two to three years without complaint.

The problem was further investigated by the posing of exhaustive enquiries on every detail of manufacture and processing without any solution other than that of negligent handling of the part being substantiated by any weight of opinion. This explanation was rejected by the makers on the grounds that it did not fit the fact that the defect was always in the same relative position no matter how the piece was handled or stacked.

Finally, to close this investigation, the chairman, MR. J. PRICE, said that for the average shop defect, after doing about five items, he would expect to be able to put his finger on the trouble. None of the members present had been able to give a satisfactory and acceptable theory. He suggested himself that a quantity of the items discussed should be taken and carefully watched through each operation, even as far back as the press shop, and never left. After such an experiment he was sure the members of the Section would look forward to hearing the result. He thanked Mr. Williams for submitting a very interesting contribution.

Scattered "Spotting"

A green-enamelled iron casting was next examined for which the "legend" was as follows:—

Obtained from a clear frit using 4 per cent. green oxide, with 5 per cent. clay and 4 per cent. sodium nitrate. The slurry had stood three weeks, was mixed and sieved and a defect of scattered dark "spotting" was observed on the ware for which the enamel was used. After allowing the slurry to stand, removing excess water and adding a small quantity of sodium nitrate the defect was considerably reduced on subsequent jobs.

Defects in Enamelling

Mr. Ball suggested the defect was rust spotting. The enamel appeared to be a cadmium green oxide which was very prone to rust spotting.

Mr. Price said he had encountered rust spotting despite the use of a reasonably good drier. Rust spotting was found on some particular irons, but was not common these days. He suggested that the sample should have been re-coated which would have indicated the real defect.

Mr. Hallsworth, knowing the plant where the job was being enamelled, would not have thought of rust spotting as the cause of the defect.

Mr. Biddulph said the trouble appeared to him to be bound up with some separation in the oxide. He found with a number of colours, particularly where yellow was present, that one could get variation in shade near the surface, similar to titanium enamel when used for cream. A series of spots in darker enamel might be caused by a slight crawling; it appeared to be associated with the ratio of the soda and borax.

Mr. Clark had recently seen this type of trouble caused through poor biscuit strength, causing a tiny crawl mark which had healed over during the firing. In similar cases he had cured the trouble by increasing the biscuit strength.

Mr. Laithwaite added that, if a slurry had too high a *p*H value, the simplest way to deal with it was to add borax; nitrate impaired the biscuit strength.

Mr. Stone suggested the enamel should be re-milled. He thought the sample exhibited rust spotting but not an orthodox type. The casting might have been dried in a portion of the drier which had aggravated the defect.

Blistering on One-coat Sheet-iron Black Enamel

Two specimens of black-enamelled sheet iron, one of which exhibited a blistering defect, were shown; details submitted were as follow:—

The defect was experienced at a small plant in which fusing was carried out in an oil-fired muffle. It caused some trouble until the source was traced to the muffle. Fallen brickwork had partly blocked the flue duct and forced a leakage of combustion products into the fusing chamber. As soon as the flue was cleared the defect ceased. The two "fired" specimens show the effect of a normal and bad fusing-chamber atmosphere. Both pieces were treated identically except that the blistered piece was fired when the muffle atmosphere was fouled with combustion products. It was believed the blisters were due to the reduction of the colour oxides in the enamel, by carbon particles or compounds of the combustion products. This reduction resulted in the formation of gas bubbles in the fused enamel.

In 100 lb. of frit there were 5 lb. clay, 5 lb. black oxide, and ¼-lb. borax to 40 lb. water. Application was by dipping.

Mr. Stone said neither of the samples was much good; he recommended the same enamel without the black oxide. As regards flue contamination, that could easily be checked if the furnace was put in vacuum not pressure.

Mr. Grainger thought one sample was quite good, while the other was very bad.

Mr. Ball said that, providing the black oxide was from a reputable firm, he would not blame the oxide. Oxides did not float, instead the frit could be said to sink. It was quite possible that the muffle atmosphere could cause the trouble; in the case of the one-coat black enamel it might have considerable effect.

Dr. Martin had found from experience with different ground coats that different furnaces firing at the same temperature would give different results. The appearance of one of the plates gave the indication that the furnace atmosphere was at fault.

Boiling on Cast-iron Enamel

Dr. Martin, introducing a defective cast-iron sample exhibiting "boiling," explained that it was typical of a trouble experienced with certain castings. He went on to say that with this type of defect the trouble was intensified by repeated enamelling. The more the casting was shotblasted the worse it became; there seemed no way in which the trouble could be minimised.

Mr. Stone said this casting was better on the reverse side and some founders would make it the other way in the mould; it was a very heavy-section casting for its type.

Mr. Price asked if the castings were annealed before enamelling.

Mr. Laithwaite replied in the affirmative.

Mr. Grainger reported that he found that a casting that showed no cavity before blasting often showed one after blasting and the more it was blasted the larger became the hole.

Mr. Stone recommended an acid pickle, followed by netralisation, annealing and shotblast for this type of casting.

Mr. Ball confessed ignorance of problems of foundry practice but knew of a firm who would enamel such castings, not by annealing more or shotblasting more, but by annealing at a lower temperature and shotblasting with finer grit, this method showed better results.

Mr. Price said that quite often an enameller might get over troubles by using unorthodox methods.

Crown Plate showing Dimples

Mr. Biddulph examining a crown-plate cooker casting which showed "dimple" defects said the plate was an example of the defect as seen in several plants; some ground coats showed the same trouble. Further questions elicited the information that the casting was dipped, was dried flat without any leaning, and that the defect was peculiar to certain driers.

Mr. Biddulph said he had encountered this trouble on several occasions where there were tiny dimples in the ground coat enamel. The cause of the dimples on the plate exhibited was found to be small particles of iron dust and it was suggested that the iron dropped on the enamel in the furnace.

Mr. Wakelim suggested the example might help to show firms with continuous furnaces the necessity for keeping the moving parts clean.

Mr. Biddulph confirmed that it did prove the necessity for cleanliness throughout the plant.

There were a number of other samples available at the meeting, but unfortunately, time did not permit further discussion and the chairman brought the meeting to a close, Mr. Laithwaite expressing thanks to those who had brought samples.

Third International Mechanical Engineering Congress

This congress is being held in Belgium from September 18 to 23. The meetings are to be held in the rooms of Fabrimetal, 21 rue des Drapiers, Brussels. There is an unusually interesting lecture course, a round of works visits and a number of social events in which the ladies will participate. We urge our readers to write to the British Engineers' Association, 32, Victoria Street, for details of this important event. It is open to industrialists and technologists.

I.V.E. Annual Conference

Provisional Programme for Harrogate Meeting, November 1 to 4

The venue of the Annual Conference of the Institute of Vitreous Enamellers has been changed to Harrogate, Yorks, where it will be held from November 1 to 4 at the Queen Hotel. The following is the provisional programme:—

Wednesday, November 1.—Evening, council meeting.

Thursday, November 2.—Morning, annual general meeting and the presidential address. In the afternoon there will be a visit to the works of Wilsons & Mathiesons, Limited, Leeds, during which a visit will be made to the vitreous-enamelling department.

Friday, November 3.—Morning, "Suspension and Biscuit Strength of Titanium Enamels," a Paper presented by Mr. H. Laithwaite, and the report of the Sheet-metal Cleaning Sub-committee, presented by Mr. S. E. A. Ryder. That afternoon, "A Study of the Use of Lithium in Vitreous Enamels" will be given by Mr. S. Hallsworth, and "Testing of Metallic Abrasives," by Dr. Riley, Mr. J. R. Park and Mr. D. K. Southwick, will be read by Dr. Riley. In the evening the annual dinner and dance will take place.

Saturday, November 4.—Morning, general discussion of questions received prior to the meeting, followed by a "Question Box" for further discussion of problems arising.

Further details will be published in due course, but members and guests are advised to make, individually, hotel reservations well in advance.

Obituary

MR. SIDNEY CHARLES MOYES, a director of Grafton Cranes, Limited, Bedford, died on July 16 at the age of 80.

MR. JOHN BLACKETT, a director of Blackett, Hutton & Company, Limited, steelfounders, of Guisborough (Yorks), died on Monday at the age of 66.

MR. CHARLES HUGHES, a director of a number of companies, including Soag Machine Tools, Limited, Lambeth, London, S.E.11, died last Friday. He was 55.

MR. JOHN EDWARD ONIONS, a director and secretary of Walter W. Coltman & Company, Limited, boilermakers, of Loughborough, died on July 20 at the age of 59.

MR. ALEXANDER BURNETT, chief draughtsman with Charles Connell & Company, Limited, engineers and shipbuilders, of Scotstoun, Glasgow, and formerly with Piet Smit, Rotterdam, died suddenly on July 14.

MR. ANDREW BRUCE, assistant commercial manager of the Falkirk Iron Company, Limited, died suddenly while on holiday in the South of England. He was 56. He joined the company when he was 14 and was appointed assistant commercial manager in 1939.

MR. T. B. BLAKEBOROUGH died recently at the age of 67. Mr. Blakeborough was for many years a director of J. Blakeborough & Sons, Limited, engineers and valve makers, Woodhouse Works, Brighouse. He was former governor of Rastrick Grammar School, president of Huddersfield Philatelic Society, and president of Castlefields Golf Club.

A SITE OF SIX ACRES at Greenock is to be developed for industrial purposes by Scottish Industrial Estates, Limited. Factories are being built there for two local firms, John Drummond & Sons, Limited, tin box manufacturers, and James Mitchell & Son (Greenock), Limited, tube and pipe benders and fitters.

News in Brief

HILL TOP FOUNDRY COMPANY, LIMITED, are planning extensions at their premises in Bilport Street, West Bromwich.

GEORGE SALTER & COMPANY, LIMITED, have drawn up plans to rebuild their foundry shop at Grice Street, West Bromwich.

MANCHESTER HEALTH COMMITTEE has agreed to recommend to the City Council that a smokeless zone be established in the centre of the city.

A NEW CANTEEN is to be erected in Commercial Road, South Shields, by Carmichael Bros., Limited, ironfounders, of Nile Street, South Shields.

MR T. P. WARD, managing director of Morton, Son & Ward, Limited, machinery merchants, of Dobcross, near Oldham, who died on December 6 last, intestate, left £4,283 gross.

A LONDON OFFICE has been opened by R. W. Sharman, Limited, structural engineers and contractors, of Sunbury-on-Thames, at 5, Victoria Street, S.W.1 (telephone: Abbey 5731).

CONSOLIDATED PNEUMATIC TOOL COMPANY, LIMITED, announce the resignation of Mr. R. E. L. Izod, A.M.I.MECH.E., their British sales manager and a member of the board of directors.

A HOLIDAY BONUS of £50 each has been given to 15 employees of Colvilles, Limited, Glasgow, who have completed 50 years with the firm.

THE OFFICE AND WORKS of the Sturdy Electric Company, Limited, are being removed to Sturdy Works, Burnopfield, Newcastle-upon-Tyne (telephone: Burnopfield 237), on August 7.

UNDER A NEW trade agreement between the Republic of Ireland and Austria, Austria's exports to Ireland will include iron, steel, and other metal products. The agreement has been initialled, and is subject to the approval of both Governments.

PERMISSION to erect one 10-ton travelling steam derrick crane and a 1-ton hand crane in connection with the construction of protective works for the Wallsend Slipway & Engineering Company, Limited, has been given by the Tyne Improvement Commission.

THOUGHT TO BE 2nd century in date, an inscribed Roman lead ingot, weighing 143 lb., was recently unearthed on the site of a new school at Carmel (Flintshire). It is the first to be found near the lead mines in North Wales and has been presented to the National Museum of Wales.

PRODUCTION ON THE GOLD COAST of sufficient aluminium to meet all United Kingdom requirements was visualised by Viscount Hall last Tuesday. He told the House of Lords that it was "a possibility" if sufficient power could be obtained from a hydro-electric scheme now being examined.

ON JULY 27, 106 members of the staff of Ley's Malleable Castings Company, Limited, Derby, were entertained by the company and afterwards were presented, by Mr. Francis Ley, with clocks and watches commemorating the completion of their 21 years' service with the firm. Three long-service certificates for 40 years' service were also presented. Up to date, 1,000 people have been presented with clocks or watches and 159 with long-service certificates.

A PARTY of 26 anglers from the Allied Ironfounders' social and sports club travelled recently from Falkirk to fish Loch Frandie, near Glendevon. This was the third and final outing for the Hill Cup, which is awarded to the angler with the heaviest catches over the three outings—Tweed, Loch Lyon and Frandie. At the weigh-in, the prizewinners were:—1st, Mr. G. Brown (M. Cockburn & Company, Limited); 2nd, Mr. J. Bennett (Falkirk Iron Company, Limited); and 3rd, Mr. P. Buchanan (Callendar Works).

Swiss Iron and Steel Works

Financial problems and the present trends in international trade were referred to when M. Walter Bloch, director-general of the L. von Roll iron and steel works at Solothurn, Switzerland, gave his annual report to shareholders.

The firm employs more than 7,000 workmen and staff, and although full-time working was maintained, this could only be done by making up arrears of orders, as the total orders received showed a drop of 40 per cent. during the financial year under review (1948-49). This was largely caused by devaluation in September last, which completely upset the price structure of the iron and steel industry and the user industries. Raw-steel prices went down by from 40 to 47 per cent., and this also applied to rolled products and foundry pig-iron, whereas fuel prices decreased by between 20 and 30 per cent. Stocks of raw materials and products, although they had been deliberately kept low for some time, therefore caused considerable losses to the firm.

German Manufacturers' Advantages

Foreign competition has been increasing, and the director's report specifically mentions Germany, where raw materials are much cheaper and wage rates are not more than 50 per cent. of those ruling in Switzerland. Cut-price competition by German manufacturers enables them to enter the Swiss market, and Swiss import duties, still based on the pre-1936 gold standard of the Swiss franc and not payable on the value, but on the weight of the goods imported, are no longer adequate to protect the Swiss manufacturer.

The company's steelworks at Gerlafingen have been similarly affected, and production also suffered severely from lack of electric power. By making up arrears and reducing prices to the levels now usual in other countries, it was possible to maintain full employment.

The gap between deliveries and new orders received by the company has been widening in the last two years. Sales during the financial year 1949-50 are expected to be one-third lower than in the previous year, with a corresponding drop in profits. As rolled products are already being sold below cost, every effort will be made to reduce the cost of production while avoiding dismissals.

Labour and State Industries

Resolutions concerning the nationalised industries bulk largely in the preliminary agenda for the Labour Party's annual conference, which opens at Margate on October 2. Several local parties have tabled resolutions expressing concern about payments to former shareholders in nationalised industries; one asks the Government to consider the possibility of withholding compensation until the national economic position improves.

The Amalgamated Engineering Union wants a review of all highly-paid executive positions in state industries with a view to an adjustment of salaries. Other resolutions urge a greater participation of the workers in management. Calls for the extension of nationalisation of industry embrace chemicals, building, and shipbuilding.

UNIFURNACES, LIMITED, have changed their address from Leeds to the Brackens, Ascot, Berks.

NEW CONVEYOR COMPANY, LIMITED, from August 1, changed their address to Newcon House, Brook Street, Smethwick, Birmingham, 40 (telephone: SMEthwick 1964).

Industrial Productivity

The Committee on Industrial Productivity, in its second report, published on Monday, recommends that it be discharged, in view of the satisfactory stage now reached in arranging for more specialised and permanent bodies to deal with most of the problems with which it has been concerned.

The Committee was set up in December, 1947, under the chairmanship of Sir Henry Tizard, F.R.S., to advise on research in natural and social sciences which would assist an early increase in industrial productivity, and to recommend how the results of the research should be applied.

The Government has accepted the recommendation that the Committee be discharged. Arrangements are being made for the work initiated by the Human Factors Panel to be carried on under the auspices of the Medical Research Council, the Department of Scientific and Industrial Research, and the British Institute of Management and other bodies concerned. The Import Substitution Panel is being re-formed to deal with the technical aspects of developing natural resources, whether designed to save imports or not.

The Committee's report declares that up to three or four years ago stress was placed on increasing the working population—a process which is now recognised to have about reached its practical limits. There is now a wider acceptance of the broad propositions that expanding national wealth and prosperity are to a large extent dependent on the greater and more intelligent application of science to production and distribution, that it is vital to aim at a steadily increasing average yearly output per person employed (as well as increases in total production), and that an objective study of human factors as they affect industry can help in the short as well as in the long run to achieve a steadily rising output.

The Committee says it is reasonable to assume that the greater part of the increased production in recent years has arisen from an increased annual output per worker. It doubts, however, whether the importance of the human side of the problem of higher productivity has even yet been given sufficient recognition. Technical improvements cannot achieve their full effect if the necessary human relations are lacking.

U.K. Shipyard Prospects

The decline in shipbuilding orders is referred to by Mr. E. J. Hill, general secretary of the Boilermakers' Society, in his letter in the Society's monthly report. He anticipates that by the end of September there will be 115 vacant berths.

Mr. Hill states that five small shipbuilding yards will have no ships building by October of this year unless orders come in immediately, and at the end of last March, 21 of the 37 shipyards in the UK had no orders for 1951. He says that of the 3.250,000 tons gross of shipping under construction or on order at the end of March, approximately 1,000,000 tons will have been completed by the end of the year. Of the 2,250,000 tons to be built or completed, approximately 900,000 tons will have been launched and in the hands of the finishing trades, leaving approximately 900,000 tons on the stocks at the end of 1950, with approximately 450,000 tons to lay down in 1951. Launching and finishing dates might be brought forward as work in the yards slackens off, thereby decreasing the tonnage on stocks and for completion.

BRADLEY & CRAVEN, LIMITED, are enlarging their canteen premises at Westgate Common Foundry, Wakefield.

Radioactive Tracers in Metallurgy

FOR THE INFORMATION and guidance of metallurgists who feel that radioactive tracers may be usefully applied in solving some of their problems, the Ministry of Supply Atomic Energy Research Establishment, Harwell, have issued a booklet on "Radioactive Tracers in Metallurgical Research" (H.M. Stationery Office, 1s. 6d.). Four chapters cover respectively: (1) "Isotope Formation and Radioactive Decay"; (2) "Detection of Radioactive Decay Particles or Radiation," both by W. S. EASTWOOD; (3) "Tracers in Metallurgy," by A. E. WILLIAMS and H. M. FINNISTON; (4) "Control of Health Hazards from Radioactive Materials," by W. G. MARLEY. It is assumed that the reader has some general knowledge of the atom, and with this proviso, the review of literature on the various aspects of the subject is quite useful. It is pointed out that tracer technique is not a universal tool which can be applied to all research problems. It has its limitations, one of which is to find a tracer with suitable nuclear characteristics. With these introductory remarks, we append extracts from the chapter on tracers in metallurgy.

Radioactive Isotopes for Use as Tracers

Two main factors determine whether a particular isotope is suitable for use as a tracer. First, the radiation emitted by the isotope must be of sufficient intensity to make accurate measurements possible. Secondly, the half life must be sufficiently long to give time for the experiment to be carried out before the radiation intensity decreases to a level comparable with that of the background. It is an advantage if the half life is long enough to make a correction for the decay of activity unnecessary. A half life very long in comparison with the time taken for the experiment is a disadvantage, however, since the radioactivity is retained after the experiments with consequent problems of cleaning apparatus, handling and storage.

In experiments using tracers (*e.g.*, diffusion measurements) it should be ensured that the decay product, if different from the tracer element, does not introduce conditions upsetting the metallurgical phenomenon being investigated. This is unlikely because of the small additions generally made.

The metallurgical research worker generally studies reactions in the solid or liquid states, or reactions between solid and solid or between solid and liquid or gas. Such reactions involve atomic movements in one way or another. It is the main feature of tracer methods that they allow the movement of specific atoms to be followed, and hence it would be expected that metallurgists would find radioactive isotopes a useful tool for research.

Of reactions in the solid state, the diffusion of one metal in another (and particularly self-diffusion) has been followed by tracers. Besides giving an insight into the diffusion mechanism, tracer methods could possibly be designed to relate plastic-flow behaviour in metals to the distribution and migration of foreign atoms, a subject which has attained importance in dislocation theory of metal flow. The results of such researches might yield important new high-strength alloys. Further, the movement of atoms during recovery, polygonisation, recrystallisation or grain growth and the location of solute atoms in precipitation and grain-boundary phenomena are of importance in an understanding of metal treatment and behaviour and tracer techniques might be devised to provide a solution to some of these problems.

The distribution of atoms between phases in alloys is also a possible field for tracer use. For example, the mechanism by which sodium modifies aluminium-silicon alloys might be investigated and the results might have application to the production of modified structures in other alloy systems; a knowledge of the distribution of alloying elements in complex steels between the various phases might lead to a better understanding of the reasons for the improved strength of such alloys; and investigation of metallic segregation and the mechanism of the breakdown of segregation by working of and diffusion in alloys might provide useful technological information. In steels, the determination of the origin of non-metallic inclusions in metals might also yield to solution by tracers.

Other Fields of Application

Three examples in the solid/liquid field might be quoted. In extraction metallurgy, the surface phenomena involved in froth flotation for ore concentration could possibly be followed by incorporating tracer quantities of the oils, wetting agents, etc., in the froth and studying the adsorption of the organic materials on the mineral surfaces. In the sphere of metal extraction or refining, the kinetics of reactions between slag and metal or between metal (or slag) and refractories could be traced by radioactive additions to metal, slag or refractory. The partition coefficient of sulphur between slag and steel would be particularly useful as part of an investigation for improved de-sulphurisation of steel. Non-ferrous metal/slag reactions will lend themselves to tracer experimental attack. The third example of solid/liquid reaction covers the field of corrosion. Such problems as filming, scaling, local corrosion, dezincification of brasses, exchange reactions are possibly amenable to tracer methods.

In solid/gas reactions, attention would be primarily directed to adsorptive phenomena and chemical activity, *e.g.*, oxidation. Much work has been done in this field and has yielded useful data on the mechanism of oxidation in copper for example. Its application to other metals, for example, those metals used in metal-ceramic seals, might yield useful information. A solid/gas phenomenon of particular interest where toxic or precious materials are involved is the transfer of solid particles in a gas stream and their carry-over to places where they are dangerous or irrecoverable.

Imports and Exports of Iron and Steel

Board of Trade Returns for June

The following tables, based on Board of Trade returns, give figures of imports and exports of iron and steel in June. Figures for the same month in 1949 are given for purposes of comparison; respective totals for the first half of this year and of 1949 are also included.

Total Exports of Iron and Steel

Destination.	Month ended June 30.		Six months ended June 30.	
	1949.	1950.	1949.	1950.
	Tons.	Tons.	Tons.	Tons.
Channel Islands ..	853	583	5,973	4,004
Gibraltar	66	95	1,009	842
Malta and Gozo ..	98	480	2,425	2,698
Cyprus	58	564	2,087	4,424
British West Africa ..	9,986	6,309	42,207	48,684
Union of South Africa	13,693	18,212	81,355	86,792
Northern Rhodesia ..	1,044	3,165	8,371	15,473
Southern Rhodesia ..	2,311	6,666	22,539	38,368
British East Africa ..	9,184	8,915	39,135	50,900
Mauritius	1,091	1,066	3,299	4,832
Bahrein, Koweit, Qatar, and Trucial Oman..	1,468	730	13,375	3,781
India	7,924	10,131	40,955	45,456
Pakistan	3,343	16,007	17,950	49,192
Malaya	6,876	6,518	28,775	42,952
Ceylon	1,042	3,023	9,512	19,067
North Borneo ..	551	689	7,500	3,645
Sarawak	19	13	968	663
Hongkong	3,180	2,575	19,770	25,229
Australia	6,830	29,835	66,685	162,950
New Zealand ..	7,643	19,344	52,174	90,722
Canada	6,151	19,736	36,495	76,823
British West Indies ..	6,696	7,084	33,509	33,367
British Guiana ..	438	521	1,912	4,153
Anglo-Egyptian Sudan	794	2,418	6,649	9,741
Other Commonwealth countries ..	1,087	611	6,134	5,818
Irish Republic ..	4,890	7,564	34,186	46,745
Russia	249	73	8,595	484
Finland	4,934	4,152	34,886	31,558
Sweden	5,466	8,666	28,661	47,151
Norway	4,257	9,565	37,096	45,319
Iceland	1,438	204	4,030	2,373
Denmark	5,269	7,564	47,594	70,545
Poland	40	94	584	1,022
Germany	112	17	411	203
Netherlands	8,339	7,055	59,800	41,392
Belgium	622	876	6,197	6,945
Luxemburg	254	104	2,857	372
France	3,786	1,918	16,487	12,754
Switzerland	1,084	636	7,457	6,308
Portugal	1,640	2,042	9,704	10,757
Spain	1,779	820	6,135	4,388
Italy	315	965	1,527	5,006
Hungary	232	—	447	256
Greece	120	217	3,088	3,096
Turkey	437	675	6,855	5,236
Indonesia*	1,547	685	14,777	8,121
Netherlands Antilles ..	1,486	757	3,812	4,804
Belgian Congo ..	44	246	724	867
Angola	31	205	3,344	1,453
Portuguese East Africa	237	599	2,331	2,712
Canary Islands ..	425	211	1,935	1,011
Syria	25	161	767	707
Lebanon	563	565	19,827	5,835
Israel	1,024	2,446	9,085	9,963
Egypt	2,827	6,390	29,157	34,763
Morocco	22	9	584	1,572
Saudi Arabia ..	728	505	2,466	1,732
Iraq	11,743	1,217	30,181	21,104
Iran	11,135	6,658	68,943	58,347
Burma	388	1,110	5,461	5,623
Thailand	164	222	2,041	3,132
China	243	1,141	2,323	2,092
Philippine Islands ..	587	539	2,202	6,078
USA	43	2,929	2,022	10,482
Cuba	16	251	210	810
Colombia	568	968	2,880	3,377
Venezuela	5,900	2,439	33,662	18,870
Ecuador	45	746	2,073	2,024
Peru	274	1,797	3,120	5,996
Chile	158	2,352	3,355	10,104
Brazil	1,293	2,850	9,019	15,288
Uruguay	723	379	4,982	4,738
Argentina	2,316	3,939	22,522	33,716
Other foreign countries	1,320	1,614	6,079	12,701
TOTAL ..	184,183	263,027	1,157,244	1,460,568

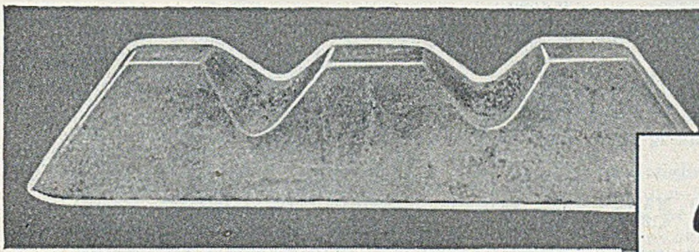
*Includes Netherlands New Guinea in 1949.

Total Imports of Iron and Steel

From	Month ended June 30.		Six months ended June 30.	
	1949.	1950.	1949.	1950.
	Tons.	Tons.	Tons.	Tons.
Australia	6,024	2	7,996	20
Canada	5,786	4,645	33,573	22,031
Other Commonwealth countries and Irish Republic ..	4,247	86	7,526	23,755
Sweden	1,990	924	9,694	6,156
Norway	3,238	3,483	17,789	24,712
Germany	2,028	7,407	4,753	47,216
Netherlands	14,033	4,573	53,828	33,052
Belgium	51,610	12,028	229,590	50,827
Luxemburg	25,352	7,931	105,836	24,394
France	27,982	30,573	105,086	139,976
Austria	9,135	26	25,739	2,287
USA	34,251	6,707	99,885	35,787
Other foreign countries ..	206	1,339	1,409	4,079
TOTAL ..	185,882	79,724	702,704	414,292
Iron ore and concentrates—				
Manganiferous ..	4,000	—	6,976	11,016
Other sorts ..	854,262	760,011	4,006,414	4,253,156
Iron and steel scrap and waste, fit only for the recovery of metal ..	188,148	221,290	801,002	1,214,957

Exports of Iron and Steel by Product

Product.	Month ended June 30.		Six months ended June 30.	
	1949.	1950.	1949.	1950.
	Tons.	Tons.	Tons.	Tons.
Pig-iron	138	1,621	2,031	13,251
Ferro-alloys, etc.—				
Ferro-tungsten ..	117	88	452	506
Spiegeleisen, ferro-manganese ..	381	124	3,482	1,096
All other descriptions	37	112	537	794
Ingots, blooms, billets, and slabs ..	168	712	1,354	3,374
Iron bars and rods ..	478	212	3,297	2,487
Sheet and tinplate bars, wire rods ..	675	625	2,060	1,860
Bright steel bars ..	1,148	3,775	10,430	20,576
Other steel bars and rods	12,367	19,953	80,944	118,420
Special steel ..	1,043	1,382	7,146	7,397
Angles, shapes, and sections ..	8,672	10,883	58,056	72,319
Castings and forgings	794	510	4,055	4,379
Girders, beams, joists, and pillars ..	1,833	6,209	13,880	32,670
Hoop and strip ..	4,305	12,292	24,496	53,032
Iron plate	328	84	1,816	1,256
Tinplates	11,255	20,456	95,963	123,736
Tinned sheets ..	319	523	2,124	1,628
Terneplates, decor. tinplates ..	37	49	190	276
Other steel plate (min. ⅛ in. thick) ..	16,508	31,333	108,662	155,702
Galvanised sheets ..	6,686	10,175	43,764	57,446
Black sheets	11,386	11,890	70,480	69,095
Other coated plates ..	684	879	3,610	5,943
Cast-iron pipes, up to 6-in. dia. ..	6,062	7,369	40,725	39,929
Do., over 6-in. dia. ..	5,282	7,182	39,939	42,623
Wrought-iron tubes ..	32,766	31,860	170,106	178,135
Railway material ..	13,924	28,654	95,284	148,778
Wire	4,300	7,432	24,550	35,929
Cable and rope ..	2,968	2,947	14,431	16,682
Netting, fencing, and mesh	1,950	1,479	10,870	8,790
Other wire manufactures	912	2,551	6,214	11,751
Nails, tacks, etc. ..	662	479	3,884	2,621
Rivets and washers ..	654	863	5,021	4,113
Wood screws	251	337	1,679	1,847
Bolts, nuts, and metal screws	2,267	2,838	12,936	15,665
Stoves, grates, etc. (excl. gas) ..	758	813	4,913	5,368
Do., gas	147	258	1,239	1,325
Baths	901	1,096	4,827	7,104
Anchors, etc.	619	552	4,687	4,408
Chains, etc.	1,084	1,150	5,223	5,342
Springs	805	727	4,227	4,002
Hollow-ware	5,895	6,415	39,114	43,986
All other manufactures	22,617	24,138	128,537	133,964
TOTAL ..	184,183	263,027	1,157,244	1,460,568



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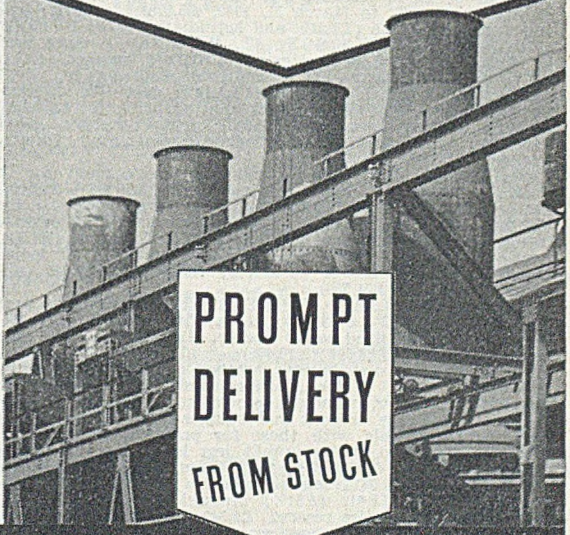


Company Results

(Figures for previous year in brackets.)

MATHER & PLATT—Interim dividend of 4% (same).

GEORGE KENT—Final dividend of 7%, making 10% (same).

RICHARDSONS WESTGARTH & COMPANY—Dividend of 12% (10%).

PIRELLI-GENERAL CABLE WORKS—Dividend of 8% and bonus of 12% (same).

BEESTON BOILER COMPANY—Final dividend of 30% (27½%), making 40% (37½%).

METAL INDUSTRIES—Final dividend of 7%, making 10% (same), on £45,000 more capital.

RUSTON & HORNSBY—Dividend of 7½% on capital as raised by 100% share bonus (12½%).

ELECTRICAL SWITCHGEAR & ASSOCIATED MANUFACTURERS—Consolidated profit to March 31, £123,909 (same).

MUREX—Final dividend of 6%, making 10%, on capital doubled by the capitalisation of £1,000,000 of reserves (final dividend of 12½%, making 20%).

RENOLD & COVENTRY CHAIN COMPANY—Consolidated trading profit of the holding company and British subsidiary, to April 2, £546,777 (£511,044); net profit, £318,940 (£264,259); tax over-provision previous years, £19,877 (£36,688); to reserve holding company, £187,000 (£173,000); dividends, £102,560 (same); forward, £156,782 (£107,525).

JOHNSON, MATTHEY & COMPANY—Consolidated accounts to March 31 show manufacturing and trading profits of the company and subsidiaries, £1,011,654 (£673,797); balance, £878,080 (£258,413); dividend of 12% (same); to stock reserves, £465,360 (nil); staff awards funds, £11Q,000 (nil); staff fund, £3,500 (same); initial allowances tax reserve, £69,600 (nil); forward, £839,708 (£678,054).

BLYTHE COLOUR WORKS—Interim dividend of 15% on capital increased to £112,500 by 50% bonus issue last December (20%). The directors say that the slightly increased interim dividend should not be regarded as an indication that the total distribution for the year is to be increased. The final dividend will, of course, depend on the recommendation of the board after examination of the completed accounts for 1950.

J. H. SANKEY & SON (HOLDINGS)—Consolidated trading profit to March 31, £131,153 (£137,207); balance, £96,782 (£101,815); to taxation, £61,781 (£59,167); capital reserve, nil (£24,604); preference dividend, £4,125 (£1,718); final ordinary dividend of 12½%, making 20% £16,500 (8¼% for the period November 1, 1948, to March 31, 1949, £6,875); forward: holding company £1,316 (£1,219) and subsidiaries £22,511 (£8,232).

WILLIAM NEILL & SON (ST. HELENS)—Trading profit to March 31, £197,187 (adjusted £180,000); balance, £81,147 (£74,632); to reserve for exceptional depreciation, £9,550 (£3,450); staff pensions, £2,641 (£2,810); executive directors' pension fund, £10,000 (nil); stock contingencies, nil (£10,000); contract contingencies, nil (£15,000); general reserve, £20,000 (£30,000); dividend of 33⅓% on larger capital (25%); forward, £54,563 (£33,940).

COGHLANS—Consolidated profit and loss account for the year to March 31 shows trading profit £26 717 (£25,007); net profit, £6,465 (£4,689); taxation overprovision, £687 (£8,000); dividend of 12½% (same); preliminary expenses of formation of subsidiaries, etc., and new articles, nil (£1,314); pensions reserve, £5,000 (nil); additional provision for income tax to cover liability of subsidiary companies, £2,000 (nil); forward, £26,370 (£31,850).

ASSOCIATED LEAD MANUFACTURERS—Trading profit for 1949, £1,382,882 (£499,905); net profit, £522,190 (£218,766); to replacement of fixed assets reserve, £150,000 (£30,000); other revenue reserves, £23,697 (£19,486); dividend of 15%, tax free, £281,630 (previous distribution absorbed £169,280 net); forward, £146,603 (£79,740). The directors state that owing to the acquisition of other businesses referred to in last year's report, the profit and loss account and balance-sheet figures are not properly comparable with those for preceding year.

METERS—Group trading profit less losses for the year to March 31, £75,893 (£53,857); net profit of group—holding company £36,445 (£30,741), less subsidiaries £25,257 (£9,233), and outside holders, £1,418 (£519); brought in (group), £35,322 (£21,063); from repairs reserve, £1,342 (£4,304); reserve freed, £2,199 (nil); to investment reserve, nil (£15,000); general reserve, £25,000 (nil); final dividend of 6%, making. 10% (same); forward—holding company £17,457, less subsidiaries £8,917, and outside holders £445, leaving £8,095 (£35,322).

RICHARD THOMAS & BALDWINS—Group trading profit for the year ended April 1 after charging provisions in excess of expenditure of £393,031 (£412,563), £6,366,564 (£6,075,636); non-recurring profits, £147,647 (£255,864); dividends from investments, £351,583 (£335,975); net profit, £1,881,757 (£1,744,952); surplus on sale of coal wagons and other assets, £3,765 (£210,393); transfer from general reserve of a subsidiary, company liquidated during the year, £84,533 (nil); to preference dividends, £171,621 (£171,619); ordinary dividend of 15% (same); provision on stocks, £349,689 (£266,025); general reserve—parent company £750,000 (£500,000), subsidiary companies £24,845 (£119,378); forward, £1,794,843 (£1,756,881).

New Companies

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

C. W. JUBY Norfolk Road, Ipswich (Suffolk). Engineers. £10,000. C. W. Juby and W. J. Reeve.

AJAX CASTING COMPANY, Bulk Works, Ridge Lane, Lancaster—£15,000. W. and T. Newsham.

JOHN H. BURY, Vulcan Tool Works, Oswaldtwistle (Lancs)—Engineers, etc. £20,000. W. and E. Youd.

HOLDEN & HAYES, Bridge Street, Oldbury, Birmingham—Ironfounders, etc. £5,000. L. Hayes and E. Holden.

HOLLINGWORTH & MAIN, Grange Road, Batley (Yorks)—General engineers, etc. £5,000. C. and A. Turner.

S. MOLE & SONS (GREEN LANE FOUNDRY), Bott Lane, Lye, near Stourbridge. £50,000. S., M., S. N., and R. O. Mole.

WANTY & COMPANY, Station Road, Catcliffe, near Rotherham—Steel and scrap merchants, etc. £10,000. I. S. Wanty.

DOUGHTY COMPONENTS, 52, Gloucester Place, London, W.1—Precision engineers, etc. £5,000. L. A. and K. M. Doughty.

WHITTAKER BROS. (SHAW), Clough, Shaw (Lancs)—General Engineers, etc. £10,000. E. and R. Whittaker, F. Hampson, and E. Wild.

MOORE & SCHOLES (ENGINEERS AND FOUNDERS), Gillibrand Street, Walton-le-Dale, near Preston. £5,000. W. Moore and G. T. Scholes.

C. ARNOLD (MARLOW BOTTOM ENGINEERING WORKS), Marlow Bottom (Bucks)—Ironfounders, etc. £8,000. A. C., L., and C. Arnold.

T. J. BROOKS & COMPANY (METALS), Chase Cross Road, Romford—£10,000. T. J. and F. E. Brooks, H. N. Wright, L. A. Burnett, and J. R. Hoar.

INSULL & POINTON, St. Mary's Engineering Works, Tunstall, Stoke-on-Trent—Engineers. £15,000. F. T. and L. T. Pointon and F. T. Pointon, junr.

WELMAC ENGINEERING, Lombard House, Gt. Charles Street, Birmingham, 3—£5,000. L. H. Davenport, R. F. Walton, H. V. H. Gundy, and E. G. Herman.

CHARLES J. FOX (BOW)—Iron and steel merchants and stockholders. £20,000. C. J. Fox, 1, Broomhill Road, Goodmayes (Essex), D. R. Bines, and H. L. Phillp.

SPIRO BALL BEARING COMPANY, Spiro Works, Regent Street, Kettering—To take over the business carried on by the Spiro Ball Bearing Company, Limited (in liquidation). £8,000. N. Manby and T. E. Ward.

Increases of Capital

Increases of capital are announced by the following companies:—

DAVID BROWN ESTATES, LIMITED, ironfounders, etc., of Meltham, Huddersfield, increased by £190,000, in £1 shares, beyond the registered capital of £10,000.

GEORGE GARNER & SONS, LIMITED, ironfounders, etc., of Openshaw, Manchester, increased by £33,000, in £1 ordinary shares, beyond the registered capital of £17,000.

JOHN BRADLEY & COMPANY, LIMITED, engineers, etc., of Bath Row, Birmingham, 15, increased by £90,000, in £1 shares, beyond the registered capital of £10,000.

T. M. BIRKETT & SONS, LIMITED, brassfounders, etc., of Hanley, Stoke-on-Trent, increased by £50,000, in 4s. ordinary shares, beyond the registered capital of £150,000.

C. F. WILSON & COMPANY (1932), LIMITED, engine manufacturers, etc., of Aberdeen, increased by £37,000, in £1 ordinary shares, beyond the registered capital of £3,000.

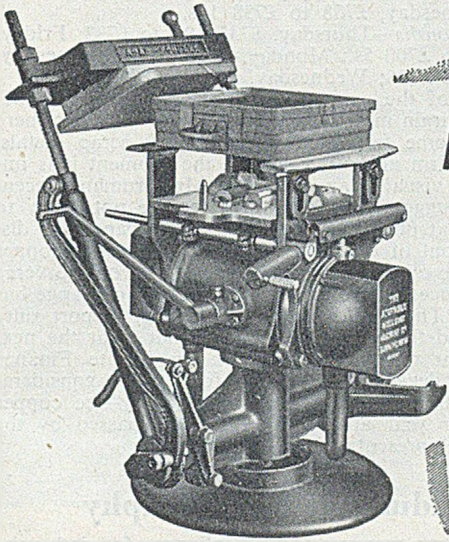
PRIEST FURNACES, LIMITED, Middlesbrough, increased by £50,000, in 49,800 5% cumulative preference and 200 ordinary shares of £1, beyond the registered capital of £12,500.

THOMAS MARSHALL & COMPANY (LOXLEY), LIMITED, firebrick manufacturers, of Loxley, Sheffield, increased by £50,000, in £1 ordinary shares, beyond the registered capital of £60,000.

BOYD-NORMAN MANUFACTURING COMPANY, LIMITED, mechanical and general engineers, etc., of Clarges Street, Mayfair, London, W.1, increased by £23,000 in 5,000 ordinary and 18,000 6 per cent. cumulative preference shares of £1, beyond the registered capital of £2,000.

COUPE & TIDMAN, LIMITED, manufacturers of refractory materials, etc., of Battersea Church Road, London, S.W.11, increased by £9,750, in £1 ordinary shares, beyond the registered capital or £5,250. At June 28, 1949, Morgan Crucible Company, Limited, held 2,622 shares out of 3,500 issued.

AUDAS & THOMSON, LIMITED, gas purification apparatus manufacturers, etc., of Eaglescliffe, Stockton-on-Tees, increased by £12,000, in £1 redeemable preference shares, beyond the registered capital of £100. Each of the 100 ordinary shares of £1 in the original capital have been subdivided into 40 shares of 6d.



ADAPTABLE SQUEEZE MACHINE

Like all the well-known "ADAPTABLE" range, this Squeeze Machine is designed for high output with low costs and can be easily altered for varying widths of plates. Dimensions as follows :—

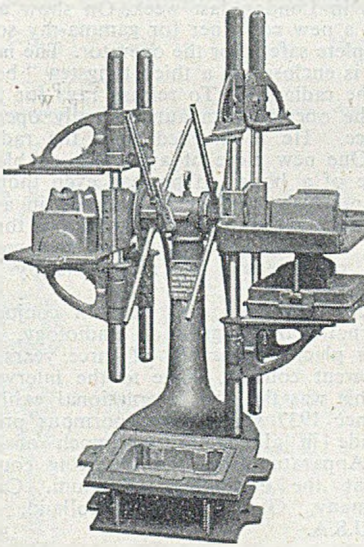
Standard Type—Plates 12in. to 20in. in width

Large Type — Plates 18in. to 26in. in width

Distance between Squeeze Rods
Standard — 24in. Large — 30in.

Pattern Draw 5in. each

Stripping Plates can be used.



ADAPTABLE DUPLEX ROLLOVER

This machine comprises two units operating independently and is suitable for single or double side (Match) plates or for core boxes. Central loading during roll-over and adaptability to varying depths of boxes are important features.

Available in two sizes :

No. 1 for boxes 24in. x 14in. x 12in.

No. 2 for boxes 36in. x 18in. x 14in.

No clamps are required. Accurate draw.

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Raw Material Markets

Iron and Steel

The engineering foundries, whose productive capacity is fully engaged, maintain a strong demand for low- and medium-phosphorus pig-irons. Available tonnages from most English furnaces are below requirements. Scotch low- and medium-phosphorus irons appear to be in somewhat better supply, but freight charges make them costly where any long distance from furnaces to foundries is involved.

Hematite producers are receiving requests for increased supplies and refined-iron makers are also assisting the foundries. Fortunately, the furnaces producing these irons have usually been able to satisfy requirements, or at least to supply sufficient quantities to provide for current production. Very little, if any, stock is held by the hematite furnaces, and most makers of refined iron are committed for their production for home and export markets. The low- and medium-phosphorus irons are already fully absorbed, and any large increase on present demands for hematite and the refined grades would be difficult to meet.

The position of the light and jobbing foundries is easier in comparison; they would welcome more work, and have little difficulty in securing sufficient supplies of pig-iron. The light foundries chiefly connected with the building trades appear to be most in need of orders, and this results in a lessened demand for the Northamptonshire grades of high-phosphorus iron. Derbyshire high-phosphorus iron remains in stringent supply, and many of the foundries using this grade have to be content with reduced tonnages.

Deliveries of foundry coke are generally sufficient for current needs, but many foundries are not receiving their full quotas of certain grades, as some suppliers are finding it difficult to despatch allocated quantities.

A good demand persists for suitable scrap, particularly for heavy cast-iron scrap.

The light mills experience a demand for the smallest sizes of sections and bars, and in many cases are able to obtain maximum outputs, but other sizes are not in such great request and some of the re-rollers are short of work. The sheet mills are very busy, and strip and wire mills remain active. Home steelworks are being pressed for sheet bars and small square and flat billets, but other sizes, owing to the present stocks held by the mills, are not in great demand.

Non-ferrous Metals

Wide price fluctuations still characterise the tin market, which closed yesterday (Wednesday) at £738 to £738 10s. for cash metal. To forecast with any pretence at accuracy the course of tin prices even a week ahead at the present time is impossible, but, on the whole, it would appear as though we might see the market working up to £750 and perhaps beyond that point. Demand from the United States is still heavy and there is, of course, no likelihood of any let-up in the rate of stockpile building at present.

Everyone who is in any way interested in the usage of tin is anxious to hold metal and to raise his holding above average because of the abnormal situation obtaining at present. Now that a free market is functioning, it is possible to hedge against the risk of loss on purchases, and this fact must have operated as an encouragement to all those who for any reason wish to hold tin unsold even for a short period. It is, indeed, fortunate that at this critical and difficult time a futures market is functioning in London. Fabricators interested in copper, zinc, and lead would be very pleased if they could be granted similar facilities.

Metal Exchange official tin quotations were as follow:

Cash—Thursday, £734 to £734 10s.; Friday, £699 15s. to £700 5s.; Monday, £712 to £713; Tuesday, £726 to £727; Wednesday, £738 to £738 10s.

Three Months—Thursday, £732 10s. to £733; Friday, £699 15s. to £700 5s.; Monday, £711 to £712; Tuesday, £725 10s. to £726; Wednesday, £734 to £735.

In spite of the onset of the holiday season, the demand for virgin metals has kept up very well, but there has been some falling-off in activity in scrap metals. Prices are firm all round, and at the moment it is impossible to visualise any decline. Mr. Truman's recent utterance suggests that ceiling prices are not likely to be applied at present, but this possibility cannot be dismissed as out of question. In New York both copper and zinc have for some time seemed to be on the verge of an advance, but at the time of writing no change has occurred. The muddle over the copper import duty persists, and there is no certainty about what the next development will be. Last week the Senate Finance Committee decided to postpone for a week consideration of a Bill which would continue duty-free copper for another year and which has been passed by the House of Representatives.

Industrial Radiography

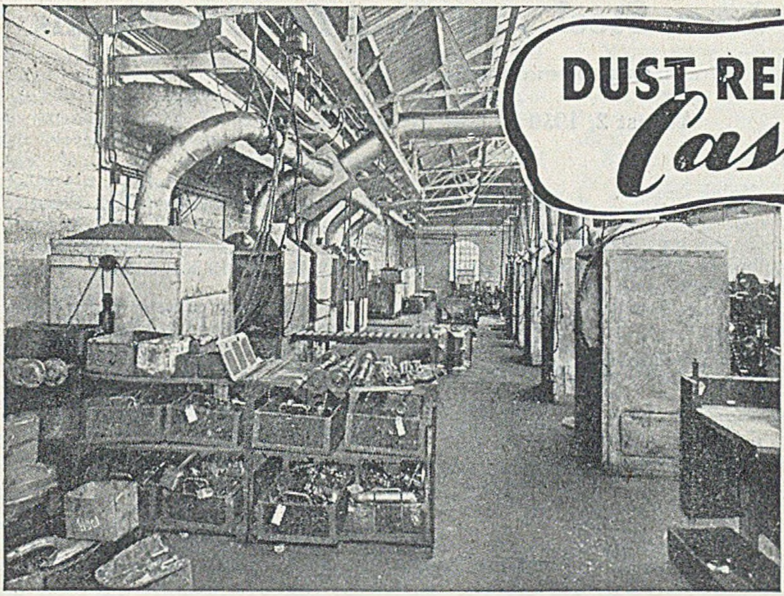
New safety measures and appliances for industrial radiographers were illustrated by the Ministry of Supply at a Radiology Exhibition, at the Royal Horticultural Society's Halls in London last week. On show at the exhibition was a new container for gamma-ray sources providing complete safety for the operator. The isotope or radon seed is enclosed in a thick tungsten " bomb " which stops the radiation. To release rays for taking radiographs, the operator can automatically open and close an orifice. He is shielded from the radiation throughout. One new piece of apparatus enables the pressure gauge of a boiler to be read even though it cannot be seen. The mercury is enclosed in a steel tube, and a gamma-ray source sends radiations through the tube and measures the height of the mercury column. The pressure can be read instantly on a cathode-ray screen.

This technical exhibition was held in conjunction with the International Congress of Radiology, which normally takes place at intervals of three years, each time in a different country. Due to the intervention of the war, this was the first international exhibition to be held since 1937 since when enormous progress has been made in almost every branch of X-ray engineering. Apparatus from the following countries was shown at the exhibition:—Belgium, Canada, France, Germany, Great Britain, Holland, Italy, Sweden, and U.S.A.

Gas Escape at Consett Iron Works

Returning a verdict of accidental death on the 11 men overcome by carbon-monoxide gas at the works of the Consett Iron Company, Limited, Consett (Co. Durham), on July 1, an inquest jury on Monday added a rider to the effect that there had been an error of judgment in not sealing off an old gas pipe by a blank (flange) before a new gas pipe was put into operation.

The coroner, Mr. William Carr, said in his summing-up that briefly the position was that because the water had got below a certain level in the seal on a gas pipe connected with one of the blast furnaces at the works, the gas had escaped. As the gas is odourless, the men had been stricken down almost before they had realised what was happening.



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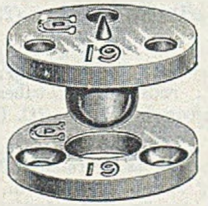

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Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered, unless otherwise stated)

August 2, 1950

PIG-IRON

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

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

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

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

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

Cold Blast.—South Staffs, £16 3s. 3d.

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

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

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

FERRO-ALLOYS

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

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

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

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

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

Ferro-tungsten.—80/85 per cent., 9s. 3d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 10s. 9d. per lb. of W.

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

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

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

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

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

SEMI-FINISHED STEEL

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

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

Sheet and Tinplate Bars.—£16 16s. 6d.

FINISHED STEEL

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

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

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

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

NON-FERROUS METALS

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

Tin.—Cash, £738 to £738 10s.; three months, £734 to £735; settlement, £738.

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

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

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

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

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

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

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £131 to £138; BS. 1400—LG3—1 (86/7/5/2), £140 to £145; BS. 1400—G1—1 (88/10/2), £185 to £244; Admiralty GM (88/10/2), virgin quality, £192 to £239, per ton, delivered.

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

Phosphor Bronze.—Strip, 31¾d. per lb.; sheets to 10 w.g., 33⅝d.; wire, 33½d.; rods, 31½d.; tubes, 36¾d.; chill cast bars: solids, 32d., cored, 33d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Ingots for raising, 2s. 2d. per lb. (7%) to 3s. 1¼d. (30%); rolled metal, 3 in. to 9 in. wide × .056, 2s. 8d. (7%) to 3s. 7¼d. (30%); to 12 in. wide, × .056, 2s. 8¼d. to 3s. 7½d.; to 25 in. wide × .056, 2s. 10¼d. to 3s. 9½d. Spoon and fork metal, unsheared, 2s. 5d. to 3s. 4¼d. Wire, 10g., in coils, 3s. 1½d. (10%) to 4s. 0¾d.; (30%). Special quality turning rod, 10%, 3s. 0½d.; 15%, 3s. 5¼d.; 18%, 3s. 9¾d.

Personal

DR. C. S. BALL has been appointed Lecturer in Industrial Metallurgy at the University of Birmingham.

MR. R. G. DUCKETT has been appointed technical sales manager with Foundry Services, Limited, Long Acre, Nechells, Birmingham.

MR. W. J. S. ROBERTS has been appointed chief metallurgist by the Steel Company of Wales at the new cold-reduction plant and tinplate works at Trostre.

DR. S. C. REDSHAW has been appointed as Professor of Civil Engineering at Birmingham University in succession to Prof. Cyril Batho, who is retiring at the end of September.

MR. D. N. TURNER, chairman of the Staveley Coal & Iron Company, Limited, Chesterfield, has been awarded the distinction of Officer (Brother) of St. John of Jerusalem in recognition of his valuable services to the St. John Ambulance Brigade.

MR. C. THOMPSON, joint managing director of J. L. Thompson & Sons, Limited, Sunderland, has been elected chairman of the Wear Shipbuilders' Association in succession to MR. A. MARR. The vice-chairman is LT-COL. R. A. BARTRAM, chairman of Bartram & Sons, Limited, Sunderland.

MR. T. R. MIDDLETON has been made a special director of the English Steel Corporation, Limited, Brightside, Sheffield. Since he joined the research laboratories at Vickers Works in 1935, Mr. Middleton has acted in a supervisory capacity in all aspects of the corporation's metallurgical work.

Changes are announced in the British Iron and Steel Research Association's panel chairmen. DR. C. SYKES, director of research of the Brown-Firth research laboratories, has retired from the chairmanship of the divisional panel of the Metallurgy Division and has been succeeded by MR. W. BARR, chief metallurgist of Colvilles, Limited.

Board Changes

WORTHINGTON-SIMPSON, LIMITED—Mr. A. Burgess has resigned from the board.

MUSGRAVE & COMPANY, LIMITED—Mr. Arthur H. Johnson has resigned his position as chairman and director.

BIRFIELD INDUSTRIES, LIMITED—Mr. H. E. Hill has been appointed chairman, in succession to the late Mr. E. J. Hardy.

HEAD, WRIGHTSON, ALDEAN, LIMITED—Mr. R. H. Sturges, general manager of the general engineering division of Head, Wrightson & Company, Limited, has been appointed a director.

BLACKBURN & GENERAL AIRCRAFT, LIMITED—Major F. A. Bumpus, managing director of the subsidiary company, Blackburn (Dumbarton), Limited, has been appointed acting managing director of the parent company.

ALLIED IRONFOUNDERS, LIMITED—The retirement is announced during the past year of three of the company's directors: Mr. A. W. Steven, chairman from 1929 to 1944; Captain H. J. Kennard, R.N.(RTD.), one of the original directors; and Mr. G. Muirie, secretary of the company since its formation and a member of the board from 1936.

SUPPORT FOR next year's British Industries Fair is such that the general closing date for the receipt of applications—August 15—may have to be brought forward in a number of trade groups and subsequent applicants placed on a waiting list. The 1951 B.I.F. will be held from April 30 to May 11, at Earls Court and Olympia in London, and at Castle Bromwich, Birmingham. Inquiries should be addressed:—London: The Director, B.I.F., Lacon House, Theobald's Road, W.C.1; Birmingham: The General Manager, B.I.F., 95, New Street.

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CLASSIFIED ADVERTISEMENTS

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

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

SITUATIONS WANTED

APPOINTMENT required with consultants, ironfounders, or concern specialising in foundry equipment, by keen and adaptable qualified Mechanical Engineer, experienced in all classes foundry plant and equipment, including mechanised foundries, general structural work, buildings, services, etc., layout, organisation and management. Salary, £1,200 upwards according to responsibilities. Excellent record and references.—Box 810, FOUNDRY TRADE JOURNAL.

FOUNDRY EXECUTIVE, M.I.B.F., 20 years' management, experienced in every branch, practical and technical, conscientious and energetic, iron and alloys, malleable and steel from cupolas and rotary furnaces, non-ferrous, seeks permanency, preferably in Midlands, but willing to move if offer attractive.—Write first to Box 834, FOUNDRY TRADE JOURNAL.

FOUNDRY MANAGER (45) (C.I.) (to 35 tons, steel, desires change to settle: varied experience jobbing work and machine tool castings; also experienced pattern shop. (M.I.B.F.)—Box 824, FOUNDRY TRADE JOURNAL.

GRAVITY DIECASTING expert requires position of responsibility. Thorough knowledge of estimating, die design and manufacture and casting production. Past 3 years Foundry Manager, previous 3 years Tool Room Foreman.—Box 826, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

A VACANCY exists in the laboratories of Ferranti, Ltd., Edinburgh, for a man with metallurgical training and experience in microphotography to be directly responsible to the Chief Chemist, Edinburgh. Opportunity to acquire experience of modern metallurgical, physico-chemical and spectro-chemical instruments. Initial salary according to experience and qualifications.—Apply, stating full details of training, qualifications and experience in chronological order, to the PERSONNEL OFFICER, Ferranti, Ltd., Ferry Road, Edinburgh.

CHEMIST, experienced in stage analysis of iron and steel, to take charge of small laboratory on the North-East Coast. Day shift only, 5-day week. —State age, experience, qualifications and salary expected, to Box 818. FOUNDRY TRADE JOURNAL.

EXPERIENCED FOUNDRY MANAGER required as assistant to present manager. Light Castings Foundry in North of England, producing 150/200 tons weekly. Good prospects with established company for man with sound practical knowledge management of floor and mechanised methods. Assistance in provision of housing accommodation arranged if necessary.—Please give full particulars and state salary to Box 816. FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

ESTIMATOR required for Iron Foundry in North-West England manufacturing Chemical and General Engineering Castings. Must have at least 10 years' experience, and be able to quote current market prices from spot examination of drawings. Ability to compute moulding, coremaking and dressing hours will be an advantage. Write giving full details, in confidence, of education and past experience. Salary about £550, according to qualifications.—Box 820, FOUNDRY TRADE JOURNAL.

FOREMAN required for machine moulding section of a grey iron foundry situated in the North Midlands. Applicants must have previous experience of a fully mechanised plant and knowledge of automobile castings production will be an advantage.—Reply in confidence, stating age and experience, to Personnel Manager, Box 822, FOUNDRY TRADE JOURNAL.

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

FOUNDRY FOREMAN required for small General and Repititon, 5 tons per day, castngs up to 10 cwts. grey iron. Knowledge of modern production methods and control of green labour. Set out pattern plates and tackle.—Full particulars of experience, age and salary required, West Riding Yorks, to Box 830, FOUNDRY TRADE JOURNAL.

FOUNDRY MANAGER with technical and practical experience in mechanised machine and floor products of grey iron and malleable castings, Birmingham. Good opportunity for first-class man with initiative.—Only applicants in receipt of a salary of £900 or over need apply, giving full details of experience, age and salary required, to Box 832, FOUNDRY TRADE JOURNAL.

REPRESENTATIVES required in London and the provinces by Scottish non-ferrous founders. Applicants must be able to obtain orders for non-ferrous castings and finished parts.—Reply 2270, WM. PORTEOUS & COMPANY, Glasgow.

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

SITUATIONS VACANT—*Contd.*

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

EDUCATIONAL

NATIONAL FOUNDRY COLLEGE.—The next session opens on 25th September, 1950. Prospective students are advised to make application without delay.—Full particulars from the HEAD OF THE NATIONAL FOUNDRY COLLEGE, Wulfruna Street, Wolverhampton.

AGENCY

LONDON Sales Agent with wide connection, seeks agency for progressive iron foundry.—Box 808, FOUNDRY TRADE JOURNAL.

PATENTS

THE proprietor of British Patent No. 561012, entitled "Locking device for load supporting pin," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to SINGER, STERN & CARLBERG, 14, East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

THE proprietor of British Patent No. 577682, entitled "Improvements in Furnace Construction," offers same for license or otherwise to ensure practical working in Great Britain.—Inquiries to SINGER, STERN & CARLBERG, 14, East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

FOUNDRIES WANTED

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

SMALL Foundry must close if other premises cannot be found. Interest offered if 750/1,000 sq. ft. available. Alternatively, priority given to firm desirous of purchasing castings with necessary accommodation to offer. Berks or Bucks preferred.—Box 812, FOUNDRY TRADE JOURNAL.

FOUNDRIES FOR SALE

AN established Jobbing Foundry capable of an output of 10/12 tons per week, and large Pattern Shop, for sale, employing 50/60 workpeople. Substantial orders on hand.—Write to Box 814, FOUNDRY TRADE JOURNAL.