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OCTOBER 29, 1953
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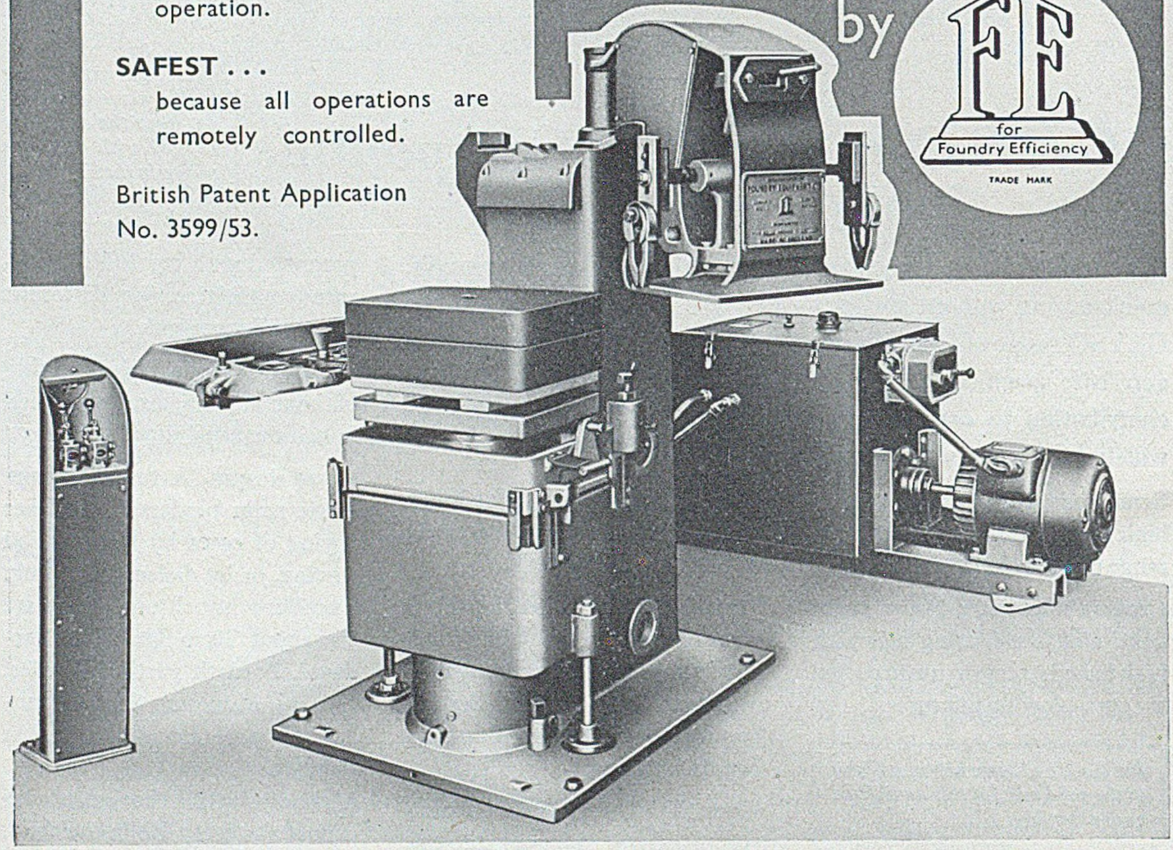

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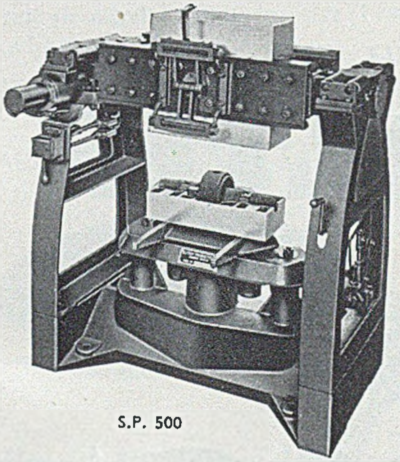

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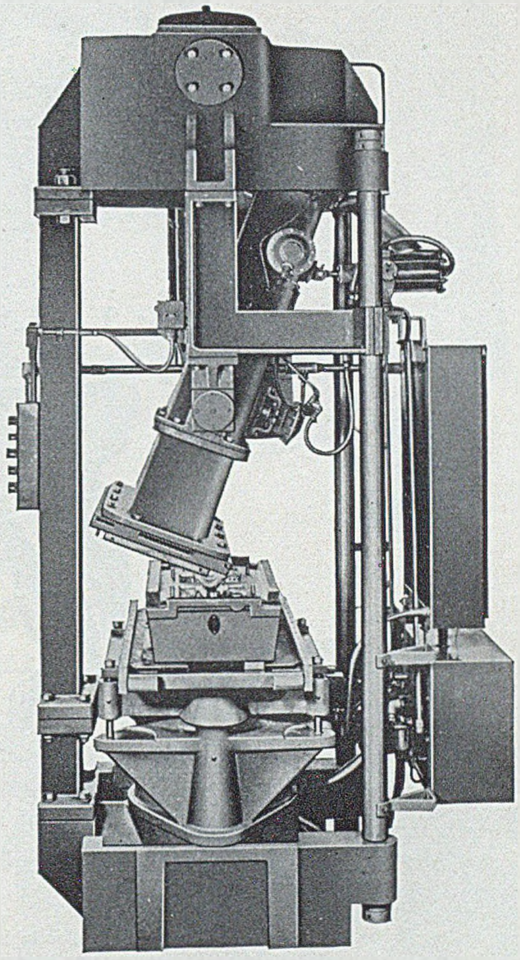

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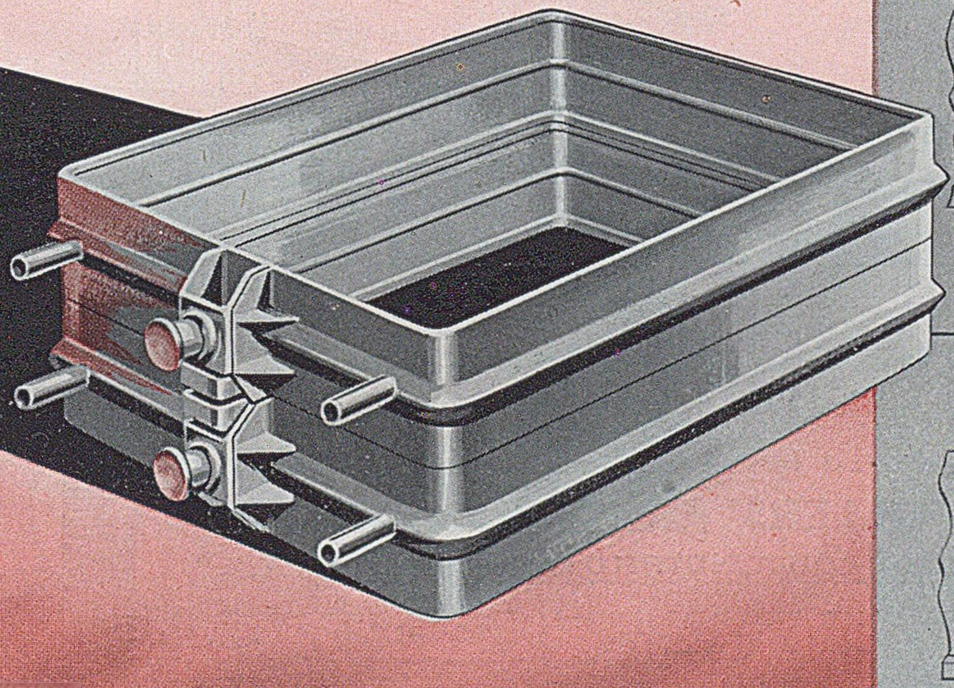

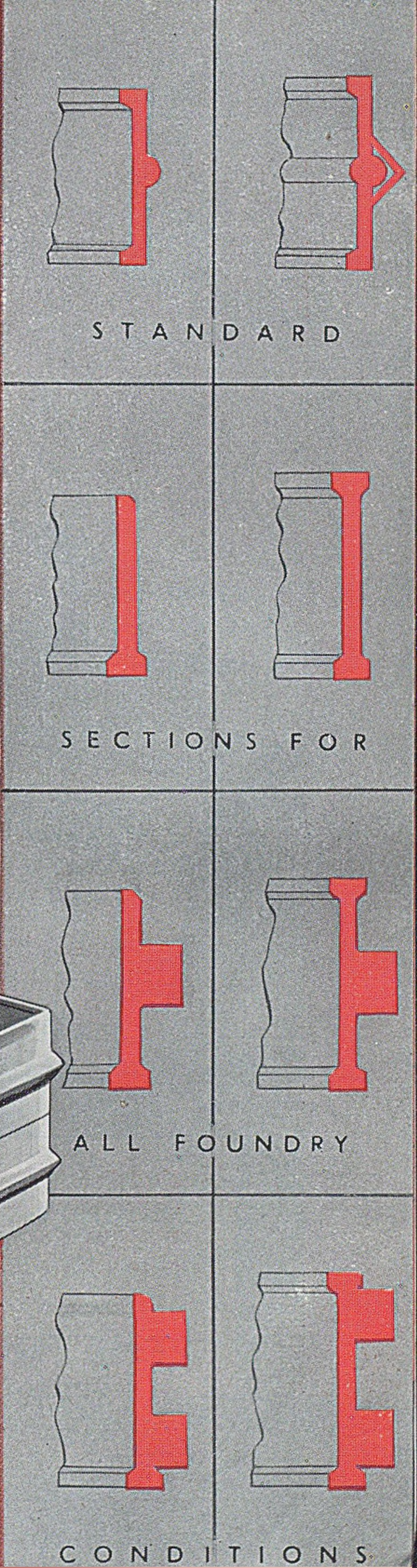

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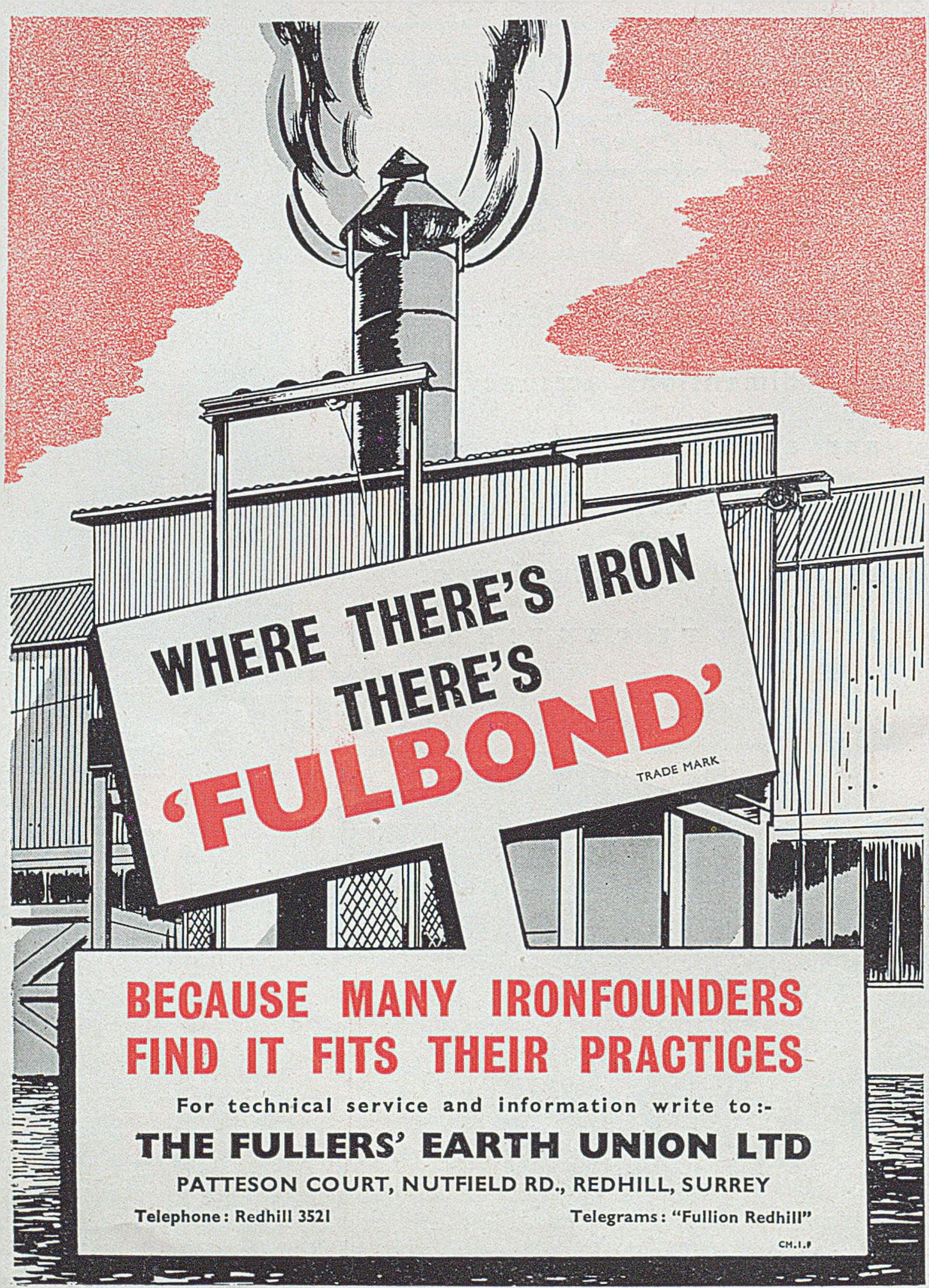
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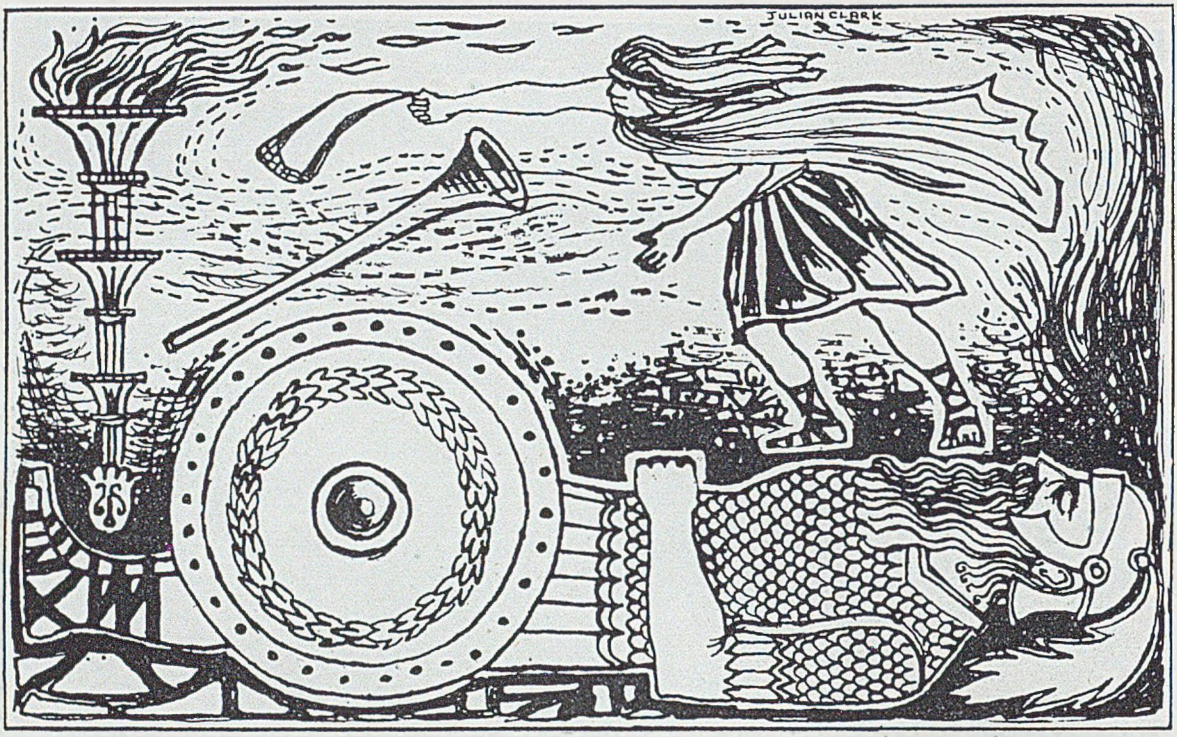
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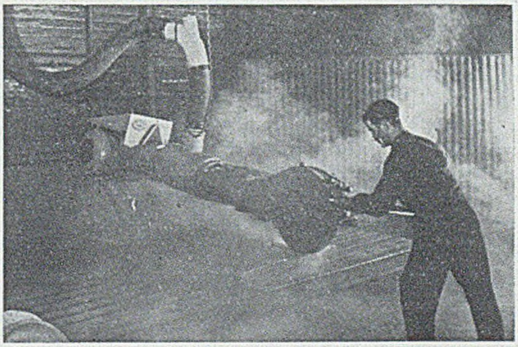

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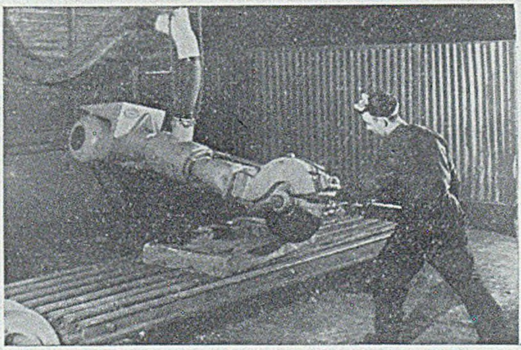

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Established 1902
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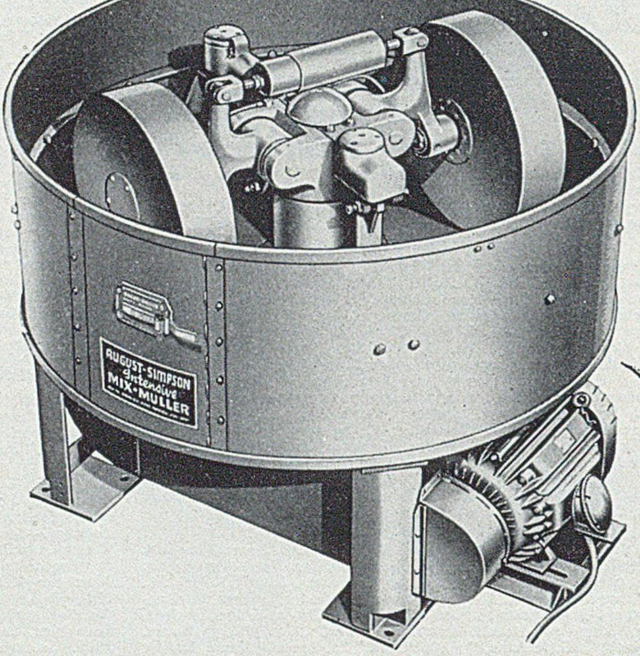

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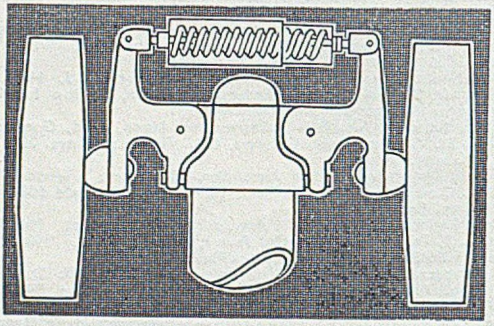

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FOUNDRY TRADE JOURNAL

Established 1902

Vol. 95 Thursday, October 29, 1953 No. 1939

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

Wider Aspects of Training

The closer one becomes associated with technical training for the foundry industry, the more fascinating it becomes. Primarily, conditions are always changing, involving new problems. Not very long ago, training was very largely undertaken by evening classes, but since day-time release has been in vogue, the demand for this type of tuition has so diminished that some technical schools and colleges have had to discontinue evening sessions. This is a pity, for the country is now losing that fine enthusiasm associated with the keener amongst both evening-class teachers and students. On the other hand, we believe that the day classes are providing a higher and better-balanced standard of instruction. Moreover, better equipment has been provided in a number of cases. In one school, even shell-moulding equipment is being installed. The notion—and a quite logical one—that foundry practice can only be properly taught on the moulding-shop floor must now go by the board, as instruction has had to be extended to include others than just moulders and coremakers.

We were somewhat astounded to find that in the foundry classes at one important foundry training college, the number of patternmaking apprentices was much greater than that of the moulders. We are informed, however, that this is no new phenomenon, but has always been the case. Thus, little wonder that so many foundry managers graduate from the patternshop! The comparative dearth of students amongst young moulders may, in part, be attributed to the monetary attraction associated with semi-skilled jobs on moulding machines, but the interruption of systematic training by military service is also a factor. In times now happily past, the foremen moulders did not approve of any technical training being given to apprentices. Maybe, as a "hang-over" from this, there is not to-day the keenness amongst this class that is essential for progress.

The cost of training apprentices is now quite a serious matter. In fact, those enlightened employers who give their boys the advantages and privileges of attending the National Foundry Craft Training Centre warrant the appellation, "philanthropists." Indeed, they are acting on the premise, "cast your bread upon the waters." It seems there are many foundry owners, needlessly footing the bill for heavy travelling expenses for apprentices who are attending technical classes outside their local educational authority, because of the non-existence of suitable courses in their immediate area. We are informed that under the Act of 1944, Educational Authorities must pay travelling expenses under such conditions. This seems to be so little known that at the moment one concern is negotiating with the trade unions on this very subject of the employers' duty—there is no question of liability to pay travelling expenses where their apprentices take classes in an "out-county" technical school. This may be well known in some areas, but we doubt if it has yet entered into the category of "general knowledge." It is a matter which should be taken up by the foundry employers' organizations, for it may be wider in application than has been indicated.

Conference Paper Authors

MR. D. N. BUTTREY, M.SC.(LOND.), A.R.I.C., A.P.I., Author of the paper "Shell-moulding Process," which is printed and discussed in this issue, was born in 1918 at Harrogate. He was educated at the William Hulme Grammar School, Manchester, and received his technical education at the Manchester College of Technology and the Royal Technical College, Salford. He has been associated with the plastics industry for 12 years, for the past eight years working specifically on synthetic resins, and has been actively concerned with the development of these materials for the foundry industry during the whole of the period. He has published two books and many papers and lectures on different aspects of plastics technology, including the application of synthetic resins to foundry practice.

Mr. B. N. AMES is the Author of the exchange paper from the American Foundrymen's Society entitled "Survey of the Shell-moulding Method of Casting Production," printed in the JOURNAL, July, 2, 9 and 16 and discussed on p. 541 of this issue. Mr. Ames was born in 1916. He was educated at the University of Alabama, graduating as a Master of Science in metallurgy, chemistry and ceramics in 1938. For the past 13 years he has been employed in the capacity of head of the Casting Development and foundry practices section of the Material Laboratory, a unit of the Bureau of Ships, Navy Department. He is the author of numerous technical articles published in the A.F.S. transactions and in trade journals on diverse foundry subjects. He is a member of the American Institute of Mining Metallurgical Engineers, the American Society for Metals and the Metal Science Club, and serves on several technical committees.

Schuman Plan Association Proposals

A new approach to Britain to join the European Coal and Steel Community as an associate, even if not a full member, is to be made by the High Authority and the six countries of the community. This was stated recently at the National Coal Board Summer School at Oxford by Mr. D. J. Ezra, N.C.B. representative on the United Kingdom permanent delegation to the High Authority of the community.

Mr. Ezra said that the time had now come for the relations between Britain and the community to be reconsidered, and the initiative in this had come from the High Authority. M. Monnet, chairman of the High Authority, had undertaken to make specific proposals for an association to the British Government during the next few weeks. The Government had already said it would study any proposals with sympathy and consideration.

Iron and Steel Institute

The autumn general meeting of the Iron and Steel Institute will be held on Tuesday and Wednesday, November 24 and 25, at the offices of the Institute, 4, Grosvenor Gardens, London, S.W.1. A Symposium on Sinter will be held immediately following the autumn general meeting on the afternoon of November 25 and all day on November 26.

Buffet luncheons (tickets 4s. 6d. per person per day) will be served in the Library of the Institute on the days of the meetings.

Members may bring guests to the meeting and the buffet luncheons. Tickets for the buffet luncheons will not be issued in advance, but members will be asked to buy them on entering the library.

Members wishing to attend any of the above functions are asked to complete the appropriate forms and return them to the secretary not later than November 20.

Detailed Programme

Tuesday, November 24

1.0-2.15 p.m.—Buffet luncheon in the Library.

2.15-2.30 p.m.—Formal business and election of members.

2.30-4.15 p.m.—Joint discussion on:—"The Effect of Emissivity and Flame Length on Heat Transfer in the Open-hearth Furnace," by M. W. Thring; "Experiments on Flame Radiation in an Empty Open-hearth Furnace," by W. P. Cashmore and M. W. Thring; and "The Length of Oil and Gas Flames," by A. L. Cude.

4.15-5.15 p.m.—Discussion: "Water-cooling of Open-hearth Furnaces," by A. M. Frankau.

Wednesday, November 25

9.45-11.30 a.m.—Joint discussion on:—"The Notched Slow-bend Test as a Brittle Fracture Test," by J. E. de Graaf and J. H. van der Veen; "The Fracture of Alpha Iron," by C. F. Tipper and E. O. Hall; "Intergranular Brittleness in Iron-oxygen Alloys," by W. P. Rees and B. E. Hopkins, and "The Cleavage Strength of Polycrystals," by N. J. Petch.

11.30 a.m.-12.0 noon—Interval for light refreshments.

12.0 noon-1.15 p.m.—Discussion on "Tensile and Impact Properties of High-purity Iron-carbon and Iron-carbon-manganese Alloys of Low-carbon Content," by N. P. Allen, W. P. Rees, B. E. Hopkins, and H. R. Tipler.

The afternoon and the following day are to be devoted to the Symposium on Sinter.

First "European" Passport

The first "European passports" were handed over to their bearers by M. Jean Monnet, president of the High Authority of the European Coal and Steel Community, at a ceremony in Luxembourg recently. The passport, or *laissez-passer*, guarantees the holder free passage across any frontier between the six Community States—Belgium, France, Germany, Italy, Luxembourg, and the Netherlands—but no privileges in passing the Customs barriers.

M. Monnet said that the Coal and Steel Community had already established the free circulation of goods between the six countries; now it was starting something which was no less important—the free circulation of persons. It was a modest but promising start, since the free circulation of persons would be authorized, for the time being, only for the officials of the community. Any official carrying the document would cross the frontiers of the six countries as if he were a citizen of those six countries. This was, indeed, the first European passport.

Extensions at Millspaugh

New Non-ferrous Foundry Opened

Yesterday saw the official opening of the new non-ferrous centrifugal foundry and ancillary shops (including a small jobbing foundry) of Millspaugh Limited, Sheffield. What follows is a brief account of the layout and methods incorporated, concluding with a brief history of the concern.

The Alsing road works of Millspaugh Limited, centrifugal founders, are situated in the east end of Sheffield and the location of the shops can be seen from Fig. 1. The new foundry has been designed to increase the quantity, quality and size range of the firm's centrifugally-cast products and reconstruction of the building (formerly occupied by Hadfields Limited—forge department) commenced at the end of June, 1952. The maximum size of casting which could be produced in the old foundry (at East Hecla works) is 48 in. dia. by 28 ft. long, whilst the new plant is capable of producing a shell 60 in. dia. by 31 ft. 6 in. long—and such a casting would probably be the longest non-ferrous centrifugal casting in the world.

In the department, there is also a small non-ferrous foundry which produces castings up to half a ton in weight from loose patterns. This section will later be mechanized to cope with the demand for De Zurik valves. The foundry buildings, which are of brick and corrugated-sheet construction, comprise of two bays, one 58 ft wide, and another 50 ft. wide, both being 350 ft. long. The larger bay (Fig. 2), which houses four melting furnaces, two casting machines and the mould-making pit and drying stove, is served by three overhead cranes of 50, 35 and 30 tons capacity. The smaller bay

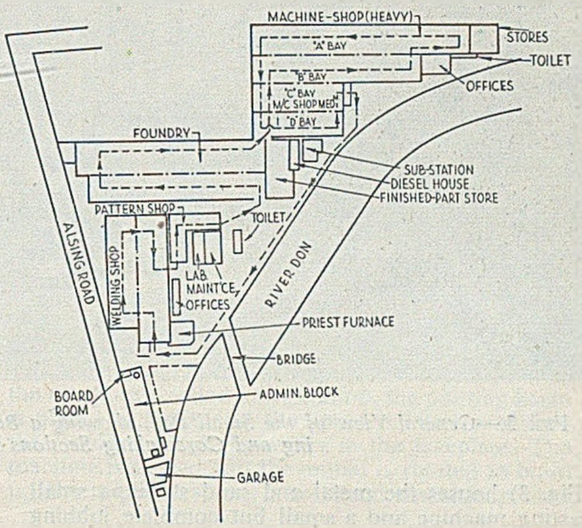

FIG. 1.—*Plan of the Millspaugh Works showing the Site of the New Foundry in Relation to the Machine-shops and Ancillary Buildings.*

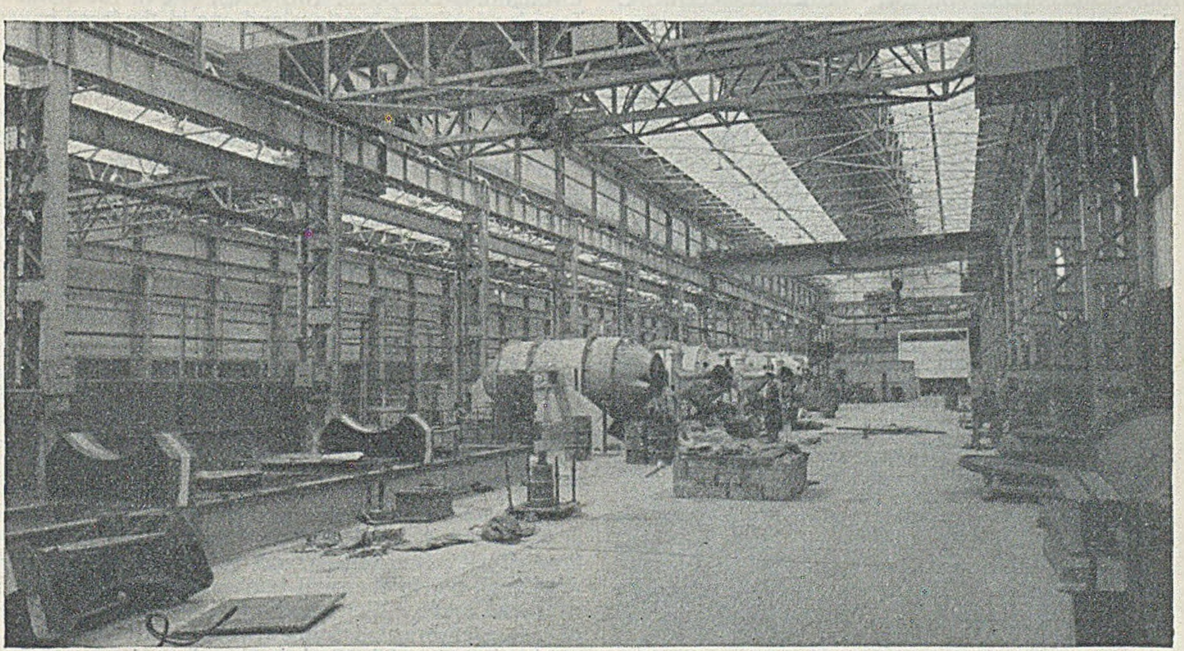

FIG. 2.—*General View of the Large Bay, showing (in the foreground) the Knock-out in Course of Erection.*

FIG. 3.—*General View of the Small Bay, showing a Battery of Three, Waterhouse Crucible Furnaces, Moulding and Coremaking Sections and Mould and Core Stoves.*

(Fig. 3) houses the metal and sand stores, a small casting machine and a small but complete jobbing foundry. This bay is served by a crane of 10-tons capacity.

The shops are painted to a colour scheme which uses dark green for the dado, cream for walls and roofs, and French blue for structural steelwork. Cranes are painted orange-red The various services are identified by colours, as follow:—town's gas, bright yellow; fuel oil, black; compressed air, black with white bands; water, pale green; and electricity (a.c.) brunswick green, (d.c.) blue, and low-voltage (for hand lamps), green with yellow bands. The shops are well lit—an intensity of 22.5 lumens per sq. ft. has been specified. Floors are of concrete throughout, except for two areas, one in the small foundry for larger castings and one in the large bay for breaking scrap.

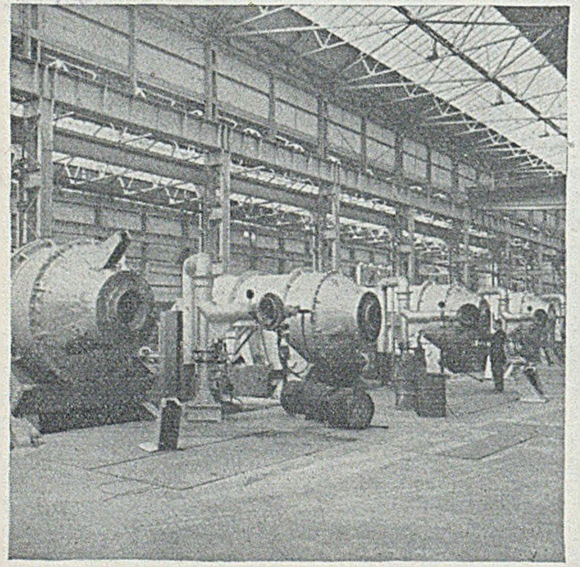

FIG. 4.—*Battery of Four, Oil-fired Stein & Atkinson, Rotary Tilting Furnaces, each of 6 tons Capacity.*

CENTRIFUGAL FOUNDRY

Sand System

In the centrifugal-casting foundry the sand system consists of an August " Simpson " No. 2 mill fitted with an automatic charging hopper and a metering device for adding moisture. The plant has a capacity approximately 1,000 lb. and an hourly output of the order of 5 tons. The mill discharges into a hopper which itself spills on to a turntable from which milled sand is ploughed off and elevated by bucket elevator to an aerator. The aerator discharges into a large storage hopper, fitted with a turntable base, from which sand is ploughed off as required and elevated by a further bucket elevator to a swivel-mounted belt conveyor which feeds sand to the moulding flasks.

Sand used is both new and reclaimed. The former is first dried in a Dunford & Elliott rotary, louvre-type dryer. Reclaimed sand is transported from the knock-out to the sand bunkers by means of an overhead crane. The knock-out consists essentially of a large fabricated framework vibrated by pneumatic vibrators The flask is placed on the carriage and vibrated, with consequent loosening of the casting which is then pulled out by the overhead crane. The plant is shown in course of erection in Fig. 2.

Metal

All alloys cast are of the non-ferrous type using only ingots and process scrap. Incoming materials from outside sources are received in the metal stores, weighed and stacked. Swarf (turnings, borings and drillings from the machine-shops are weighed, tipped in appropriate bunkers, then passed through a Dunford & Elliott rotary louvre-type drier to which has been coupled a magnetic separator. The clean, dry material is then stored in the dry, side bunkers. Metal is transported to the furnaces by means of a Conveyancer fork-lift truck fitted with a forward-tipping lip-axis discharge pan. This truck, with its special stillages, is also used for charging the furnaces.

Furnaces

For melting, the centrifugal-casting foundry is served by a battery of four Stein & Atkinson oil-fired rotary tilting furnaces each of 6-tons nominal capacity (Fig. 4). These furnaces may be tilted to the vertical to facilitate lining (linings are monolithic), to an angle of 30 deg. for charging and nose-end downwards for tapping. Once metal is charged, the furnaces are rotated to give faster melting and longer lining life. The products of combustion are removed by downtakes which lead to a common flue ending in a chimney 80-ft. high. Charging and tapping are carried on from the front or burner end and slagging is from the exhaust end into a slag bogie fitted beneath the furnaces.

Using Britroleum fuel-oil through Urqhart burners, these furnaces are capable of a firing rate as high as 45 galls. per hr., but preliminary trials have shown that 5 tons of gunmetal ingots can be melted, from a hot start, in 1½ hours, with a firing rate of the order of 300 galls. per hr.

Ladles.—A number of varying types of ladle are used, ranging from ½- to 26-tons capacity. The smaller ladles are lined with rammed "compo" and are lip-pouring, whilst the larger are tiled and are of the stopper-pouring type. All ladles are preheated by means of oil or gas torches.

Mould Making

It should be pointed out that the output from this foundry is largely comprised of heavy non-ferrous cylinders and moulding, knock-out, and ancillary equipment is installed specially to deal with this class of work. Moulding flasks (which in this foundry are all cylindrical) are fitted with a stop-off, set according to the length of casting required, and are then placed vertically on a 7-ft. dia. turntable, which is installed at the bottom of a pit 20 ft. deep. The flask is located centrally by means of a spigot on the turntable and a corresponding hole in the end-plate of the flask, the upper part being held true by means of pneumatically-operated, adjustable steadies.

The plug or pattern, which may be of wood or metal, is lowered into the flask from a hoist fitted to the overhead crane and is located centrally in the stop-off, by means of a spigot. The turntable is then rotated—at a speed varying with the wall thickness of sand and the mould diameter—and sand is fed into the annulus between the pattern and flask, from the overhead swivel conveyor. Operators, standing on a platform above the mould, steady a pneumatic rammer which consolidates the sand as it passes beneath the rammer head (see Fig. 5).

Sand is rammed to the top of the pattern which is then lifted 3 or 4 in. and the process repeated until the mould is complete. The plug is then stripped and the mould inspected and, finally, blacked by means of either circular brushes (in the case of the smaller moulds) or by hand by a moulder lowered inside by the hoist (on larger moulds). The completed mould is lifted from the turntable and placed horizontally on the bogie of the mould-drying stove. This stove, manufactured by Modern Furnaces & Stoves Limited, is oil-fired and works on the recirculation system (Fig. 6).

Casting

The flask containing the dried mould is placed upon the rollers of a casting machine of the appropriate size; a front plate is fitted on the open end, and sealed up. A canopy-type guard mounted over the machine is rolled into position, the pouring basin is placed in front, and the spout is introduced into the mould through the orifice in the faceplate. The machine is started and the mould is rotated to build up the requisite speed, whereupon metal is poured

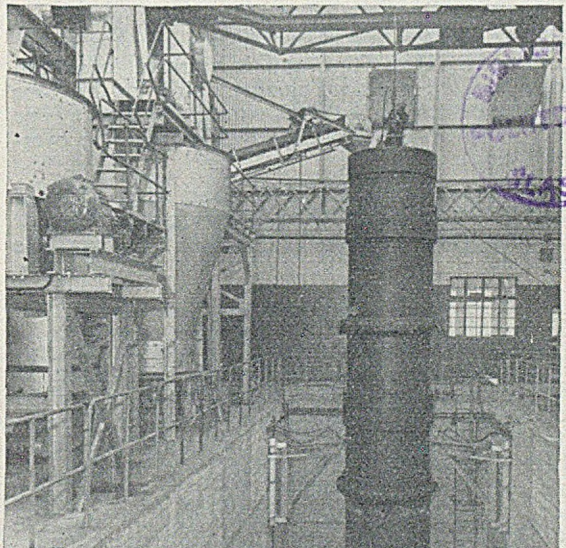

FIG. 5.—*Ramming in Progress for a Flask 66 in. i.d. and 33 ft. long. The weight of Finished Mould is 43 tons.*

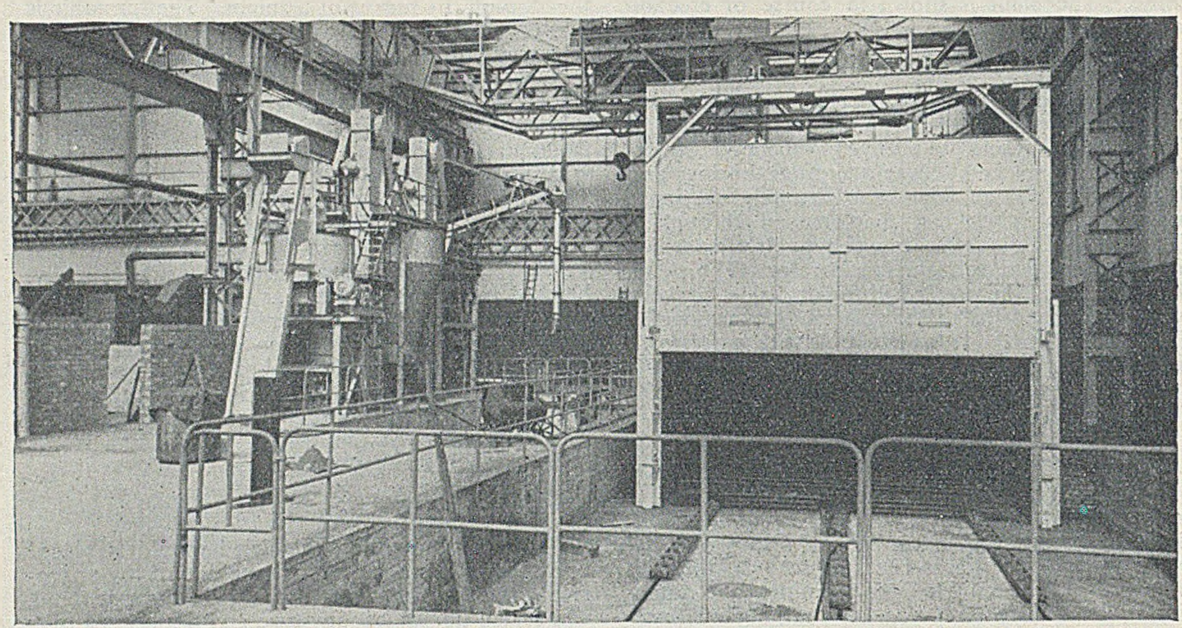

FIG. 6.—(*Right*) *Oil-fired Recircularization-type Mould-drying Stove;* (*Left*) *Ramming Pit and Sand-preparation Plant.*

from the ladle, through the pouring and into the mould.

When the casting is " black," the flask is removed from the rollers and placed on the carriage of the knock-out. Here, the sand is vibrated loose and then the flask is placed against a stop on the floor and the casting pulled out by means of a wire rope over a snatch-block pulley leading from the overhead crane.

Castings are normally quite clean when removed from the knock-out; such fettling as may be required is done with pneumatic chisels and portable grinders.

Small Foundry

Also in the new set-up a small non-ferrous jobbing shop has been incorporated (as shown in Fig. 1). Here, methods and equipment include the following:—For the sand plant—" Morris " Screenator and Pneulec sand mill; for metal smelting—three Waterhouse, 600-lb. capacity crucible furnaces and one Monometer 400-lb. furnace; moulding is done from loose patterns throughout; mould and core drying is carried on in two oil-fired recirculation-type ovens made by Modern Furnaces & Stoves Limited; knockout is by hand; for cleaning, all castings are shot-blasted by a local firm, and for cutting-off, a Coleman-Wallwork machine is used along with pneumatic grinders and hammers for trimming.

Social Conditions

Every effort has been made to provide clean, well-lit and well-ventilated shops. There are no baths as yet, but these are envisaged as a later development. Adequate cloak room accommodation and washing facilities in the way of hot and cold water sprays and washbasins are provided.

HISTORICAL

In 1933, W. H. Millspaugh, who founded the private company of Millspaugh Limited, developed the centrifugal process for the manufacture of large non-ferrous tubes in the United States, and came to England to experiment in the casting of steel tubes. By arrangement with Sir Robert Hadfield, he obtained accommodation for his foundry adjacent to Hadfields Limited, East Hecla steel department, and housed his machine-tools in one bay of their No. 4 machine-shop. Two casting machines for producing castings of 15 to 44 in. o/d by 29 ft. long were installed and applied to the production of bronze shells for the paper-making industry, in order to provide funds for his experiments in casting steel.

The year 1936 saw the extension of the smaller of the two machines to produce liners for ships' propeller shafts, the first of which were 18 in. o/d by 32 ft. 10 in. long, and this, together with the growing importance of the Millspaugh suction roll and other developments in paper-making machinery, outpaced the early experiments in steel casting which had been confined to the manufacture of equipment for the foundry. In 1939, the outbreak of war curtailed the development of paper-making machinery and special machines were designed and installed to produce components for aircraft, tanks, guns and propeller-shaft liners for special naval craft on a semi-mass-production basis. The knowledge gained from the early experiments in steel casting was applied to special development work and a substantial tonnage of steel castings for special applications was produced.

Post-war Progress

At the end of the war, Millspaugh Limited became a subsidiary of Hadfields Limited, and the development of the paper-making machinery and general engineering side of the business was encouraged, with consequent expansion of the machine-shops and the building of a welding shop. In February, 1951, Millspaugh Limited were "hived-off" from the parent company, a new administration block was completed at Alsing road and it became essential to remove the foundry to a new site adjacent to the other departments. Hadfields Limited vacated their old forge in June, 1952, and the site became available for the erection of the new foundry.

At this stage, the development of the company was so rapid and the range of products became so much wider that the new foundry had to be planned to meet a much higher rate of output over a far wider range of sizes. Castings of from 5 in. o/d by 10 ft. in length to 60 in. o/d by 31 ft. in length (probably the largest casting of its type in the world) can now be produced and the machines and equipment have been designed to shorten the manufacturing cycle to such an extent that four times the output is possible. The completion of the Alsing road foundry in this, the Coronation year, is a fitting crown to 20 years of continuous development.

American Foundrymen

A party of American foundrymen arrived in London last Saturday night, some coming by the boat from Ostend and others flying in from Holland. The former party headed by Mr. Shannon were met at Victoria Station by Mr. Levy, the president of the London branch, Mr. T. Makemson, the secretary, Mr. V. C. Faulkner, a past-president of the Institute, Mr. Mochrie, the London branch secretary, Mr. Dickinson, of the Mond Nickel Company, Limited, Mr. Wizard, of Sundry Equipment Manufacturers, Limited, and Mr. Parkes, of FOUNDRY TRADE JOURNAL.

The visitors spent Sunday and Monday in London; on Tuesday and Wednesday they went to the Birmingham area, whilst to-night they are to be entertained to a cocktail party on board the ship Wellington, moored off the Victoria Embankment, by kind permission of the Master of the Honourable Company of Master Mariners. The leaders of the party will then be entertained to dinner at the Savoy Hotel.

Beilby Memorial Awards

Consideration will be given to the making of an award or awards from the Beilby Memorial Fund early in 1954. Outstanding work may be brought to the notice of the administrators, either by persons who desire to recommend the candidate or by the candidate himself, *not later than December* 31, 1953, by letter addressed to the convener of the administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30, Russell Square, London, W.C.1. The letter should be accompanied by *nine copies* of a short statement on the candidate's career (date of birth, education and experience, degrees and other qualifications, special awards, etc., with dates) and of a list of references to papers or other works published by the candidate, independently or jointly.

Platinum Metals in Industry

Many people believe that the platinum group metals are used exclusively for jewellery and luxury applications, and would be surprised to learn that at least 75 per cent. of the total production of these metals is consumed in industrial applications. Utilization has been greatly assisted by the improved methods of refining that have been developed in recent years. The main uses of these metals result from their high melting points and great resistance to corrosion and oxidization. Workability, which varies greatly among the six metals of the group, also determines their respective fields of use.

How important and widespread are the uses of the platinum metals was demonstrated at an exhibition organized by the Institution of Metallurgists, which was held last week to commemorate the triple jubilee of William Hyde Wollaston's discovery of palladium. Located at Grosvenor House, Park Lane, London, W.1, the exhibition was officially opened by the Duke of Edinburgh on October 19 and closed last Saturday. During a luncheon which immediately preceded the opening ceremony, the president of the Institution of Metallurgists, Dr. L. B. Pfeil, presented his Royal Highness, acting on behalf of the Queen, with an inscribed powder compact box made entirely of metals of the platinum group, platinum and palladium predominating. This unique box was designed by Mr. Stephen Gooden, R.A.

It is fortunate that the two most abundant metals of the group, platinum and palladium, are ductile and malleable. In contrast, rhodium and iridium can be worked only with difficulty, and it is not yet possible to work ruthenium and osmium satisfactorily at all. Platinum, palladium, and their alloys are generally used in wrought form. Ruthenium, osmium, and iridium find their main applications as hardening additions to platinum and palladium, while rhodium, in addition to its use in platinum alloys, finds considerable application as an electodeposit.

One section of the exhibition consisted of an interesting collection of items connected with Wollaston and his discoveries and with the early history of the platinum metals. Exhibits included a design for a palladium cup presented to Charles X of France in 1824 by Robert Breant, chief assayer to the Paris Mint, and an inventory, in Faraday's hand, made in 1834 of the platinum and palladium given to the Royal Society by Wollaston. Photographs of jewellery made by American Indians before the time of Columbus were displayed. The Indians had developed effective techniques for working alluvial platinum and gold, the crude form of gold being melted with copper to give a gold coloured alloy containing traces of silver and platinum. The platinum grains which could not then be melted were brought into workable form by heating with small amounts of gold. Repeated heating and hammering yielded a homogeneous white alloy which was principally used for overlaying on gold.

Institute Elects New Members

At a Council meeting of the Institute of British Foundrymen, held at Birmingham on October 17, the following were admitted to membership of the Institute in the grades indicated:—

As Subscribing Firm

A. Fryer & Sons, Limited, Willenhall, Staffs (representative: J. Fryer).

As Members

S. Ahmed, Loco Works, N.W.R., Lahore; F. W. Boswell, Reliance Foundry Norwood, Limited, London; J. Boyle, Sloan & Davidson, Limited, Leeds; C. W. Briggs, Steel Founders' Society of America, Cleveland; G. N. Covington, Reliance Foundry Norwood, Limited; H. R. Dowler, H. J. Dowler, Engineers' (Patternmakers), Limited, Birmingham; A. G. Downing, Pattern Makers (Engineering) Company, Limited, Willesden; J. A. E. Earp, General Refractories, Limited, Sheffield; W. G. Evans, Bagshawe & Company, Limited, Dunstable; J. Fryer, A. Fryer & Sons, Limited; J. T. Green, Trianco, Limited, Hanworth, Middlesex; J. B. Henderson, Trinity Foundry, Limited, Wakefield; K. Heughan, H. & F. Precise Castings, Limited, Derby; V. Hornig, "Precima" Instrument Company, Birmingham; S. Lee, Hillsyde Foundry Company, Stoke-on-Trent; F. S. J. Leigh, Birlec, Limited, Birmingham; H. S. Newton, Northfield Foundry, Limited, Brixham; A. H. Philips, Swan Foundry (Banbury), Limited; R. Reitsema, Metaalinstituut T.N.O. (Metal Research Institute), Delft, Netherlands; H. Rogerson, Ford Motor Company, Limited, Dagenham; F. W. T. Rymill, F. T. Rymill & Son, London; C. W. Stewart, Chas. W. Taylor & Son, Limited, South Shields; W. J. Sully, Sterling Metals, Limited, Coventry; W. G. Taylor, Robert Taylor & Company, Limited, Larbert; T. F. Tollett, Tollett & Sutton, Limited, Birmingham; G. H. Worner, Richard Thomas & Baldwins, Limited, Swansea.

Transfers from Associate Member to Member

P. Cook, Daralum Castings, Limited, Darlington; F. S. Cox, Newton Chambers & Company, Limited, Sheffield; R. N. Gandhi, Texmaco (Gwalior), Limited, India; L. A. S. Harbourne, M.C., Morgan Crucible Company, Limited, London; C. S. Johnson, Leyland Motors, Limited.

As Associate Members

J. A. Armstrong, Sterling Metals, Limited; D. V. Atterton, Foundry Services, Limited, Birmingham; H. Barker, Braeside Foundry Company, Oswaldtwistle; G. S. Bates, Light Alloys, Limited, London; D. H. Bilton, Deans & Son (Yorkshire), Limited, Beverley; J. W. Bunnah, Whites-Nunan, Limited, Pendleton; J. Carlin, Distington Engineering Company, Limited, Cumberland; T. A. Cosh, British Steel Castings Research Association, Sheffield; J. B. Cruddas, Wear Winch Foundry Company, Limited, Sunderland; A. S. Darby, Bagshawe & Company, Limited, Dunstable; J. L. Davies, Bagshawe & Company, Limited; J. W. Deakin, New Eagle Foundry Company, Limited, Birmingham; B. D. Deshmukh, Mysore Kirloskar, Limited, India; J. Dodd, Bradley & Foster, Limited, Darlaston; C. Drinkwater, Ford Motor Company, Limited; F. F. Dyer, Bagshawe & Company, Limited; S. Greenhalgh, Stanton Ironworks Company, Limited; J. L. Gyte, Lee & Sons, Sheffield; W. B. Hendry, Smith Patterson & Company, Limited, Blaydon-on-Tyne; J. R. Herdman, Harborough Construction Company, Limited; P. B. Heslop, Stanton Ironworks Company, Limited; W. Hunter, C.W.S. Ironworks, Keighley; A. Issaakidis, Union Metal Works (Pty.), Limited, Germiston, South Africa; M. B. Jones, Wright & Platt, Limited, Birmingham; C. G. Johnson, Bagshawe & Company, Limited; K. J. Joshi, Texmaco (Gwalior), Limited, India; A. W. King, Bagshawe & Company, Limited; J. R. Meyer, Coleman-Wallwork Company, Limited; G. T. Milan, Woodhouse & Company, Limited, Doncaster; E. H. Moseley, Bagshawe & Company, Limited; R. Ody, Ford Motor Company, Limited; T. D. Oughton, Crane, Limited, Ipswich; P. C. Packham, A.P.V. Paramount Company, Limited, Crawley, Sussex; H. E. Sell, A. & A. Models (Wood), Limited, London; D. R. Sen, Burn & Company, Limited, Howrah, India; F. A. Summers, Ashwell & Nesbit, Limited, Leicester; C. Taylor, Wm. Cook & Sons (Sheffield), Limited; R. W. Turton, A.P.V. Paramount, Limited; L. J. Venables, E. W. Wynn (Ironfounders), Limited, Cannock.

Transfers from Associate to Associate Member

J. Andrews, Higham Foundry & Cleveland Castings, West Bromwich; D. H. Butler, Phosphor Bronze Company, Limited, Birmingham; D. Chatterjee, Leyland Motors, Limited; E. C. Davies, Richard Thomas & Baldwins, Limited, Griffithstown, Mon.; C. M. Dunks, Bryan Donkin & Company, Limited, Chesterfield; T. Evans, British Railways, Horwich; A. T. Green, Guest Keen & Nettlefolds, Limited, Cwmbran, Mon.; P. A. Green, Swansea Foundry & Engineering, Limited, Morriston; S. J. Heritage, Sheepbridge Engineering Company, Limited, Chesterfield; C. Raybould, Bilston Foundries, Limited; I. Strode, Glanmor Foundry Company, Limited, Llanelly.

As Associates (over 21)

V. B. Anand, Nahan Foundry, Limited, India; R. Davies, Sterling Metals, Limited; R. W. Durrans, Thomas Broadbent & Sons, Limited, Huddersfield; E. Farquhar, G. P. Wilson's (Engineers), Limited, Southampton; J. S. Gill, Nahan Foundry, Limited; A. M. Gupta, Texmaco (Gwalior), Limited; D. A. Haslock, Leeds Piston Ring Company, Limited; T. Hopper, Wear Winch Foundry Company, Limited; F. J. Jaggar, Keighley Laboratories, Limited; O. P. Kingar, Ordnance Factory, Muradnagar, India; F. C. Lathwood, Ruston & Hornsby, Limited, Lincoln; T. R. J. Lawrence, Phosphor Bronze Company, Limited; D. R. Leyshon, Richard Thomas & Baldwins, Limited, Swansea; F. List, Henry Edie & Company, London; D. P. Neogy, Ordnance Factory, Meerut, India; D. Rathbone, Hale & Hale (Tipton), Limited; I. Roderick, Richard Thomas & Baldwins, Limited; T. F. T. Shearer, Richard Thomas & Baldwins, Limited.

As Associates (under 21)

D. Collett, Sterling Metals, Limited; K. Freeman, Castings, Limited, Walsall; M. M. Killen, Wear Winch Foundry Company, Limited; C. P. Lawton, Dartmouth Auto Castings, Limited, Smethwick; D. D. MacFarlane, University of Glasgow; D. Miller, Wadkin & Company, Leicester; K. Rhodes, Newton Chambers & Company, Limited, Sheffield; T. P. Roddy, Sir W. H. Bailey & Company, Limited, Patricroft; D. M. P. Scott, Douglas Fraser & Sons, Arbroath.

An agreement has been completed between Simms Motor Units, Limited, London, N.2, and the American Bosch Corporation, Springfield, Mass., which provides for a complete interchange of engineering knowledge and technical information on the production of fuel injection apparatus, principally for Diesel engines. The U.K. company has also been granted the British manufacturing rights under American Bosch patents, while American Bosch can now manufacture units of Simms' design in the U.S. Users of products made under the agreement will be able to obtain service through the service organizations of both companies.

Shell-moulding Process*

By D. N. Buttrey, M.Sc., A.R.I.C., A.P.I.

The paper discusses the present position of the shell-moulding process and describes techniques available for making shell moulds. In the United States, the shell process is beginning to be used on quite a wide scale, and a number of engineering companies are manufacturing commercial machines for making shell moulds. In Great Britain, translation of the process to the production scale has been slower, although a limited number of foundries are now producing castings by using shell-moulding techniques. Interest in the process is widespread and considerable development work is being done at the present time. The process offers promise of being used on a major scale throughout the foundry industry within a few years.

On the technical side, satisfactory techniques for producing shells have now been established. Difficulties of separation of shells from patterns have been resolved by the introduction of silicone separating agents in liquid, emulsion and grease form. At the same time, other satisfactory separating agents based on waxes, organic greases and polymers are now available. There is being built up a technical background to the process, covering different factors such as the influence of sand particle-size on finish and strength of shells, the effect of pattern and oven temperature on shell build-up and hardening rate, the properties of different patternmaking materials and suitability of the process for the casting of various metals. The shell-moulding process offers distinct advantages for many types of casting over conventional foundry techniques, the most notable being the superior finish on castings, the ability to cast to closer tolerances, the greater ease of casting thin sections, reduction of "blowing" in castings and reduced finishing costs in the form of savings in fettling. At the present time, development is being concentrated on improved resin binders for making the shells, mechanization of the process, investigation of casting sizes possible by the process and the suitability of the process for casting ranges of metals.

Introduction

The first technical details of the shell-moulding process, also referred to as the "C" process, based on the interrogation by W. W. McCullogh (of the Technical Industrial Intelligence Division, U.S. Dept. of Commerce) of J. Croning in Hamburg, were published as Report No. 1168 of the Office of Technical Services, U.S. Dept. of Commerce, on May 30, 1947. It is reported[1] that a patent application (No. 48679) was filed in the German patent office on February 1, 1944, on the process of making thin moulds and cores with approximately uniform wall thickness, from dry-sand/resin mixtures, also including the use of fillers such as metal powder, metal oxides and graphite. This patent application was kept secret by the German Government, although by June, 1944, the process was in production at several foundries[1,2] and at the firm of Haller Werke A.G. in Hamburg-Altona the production of cores for 8-cm. hand-grenades by the process had reached a figure of 6,000 components per day.

Since 1947, development of the shell-moulding process has proceeded more rapidly in the United States than in Great Britain and it is now being used in a number of foundries, including that of the Ford Motor Company (U.S.A.) where, it is stated,[3] an estimated 150 tons per day of metal is poured into shell moulds to make at least 40,000 exhaust valves daily, and also camshafts, crankshafts and rocker arms; it is estimated that in the new Ford "6," shell-moulded parts comprise approximately 15 per cent. of the total engine weight, and to date this company has invested perhaps $8 million in the process. In Great Britain, the process is now in operation in several foundries although as yet on a comparatively limited scale; during the past year, however, interest in it has been considerable and development work is now widespread. In Denmark,[4] from December, 1950, to July, 1951, some 6,000 small engine cylinders were produced by the process and, in spite of the experimental nature of the production, the total percentage of waste was below the previous figures relating to oil-sand moulded cylinders.

It is reported[3] that at least six companies in the United States are at work on commercial machines for making shell moulds and their designs are of two general types, *i.e.*, single-station machines, which provide a single pattern with its own oven, and multi-station machines carrying from two to a dozen patterns through a common oven. The multi-station machines are designed for mass-production work, one machine producing 1,000 shell moulds per hour on a 12-station turntable. British Patents have been granted relating to apparatus for making casting cores and the production of metal patterns, and apparatus for cooling shell moulds during casting.[5]

Estimates on the future of shell moulding in the United States have been very ambitious, for example it has been forecast[3] that resin consumption by the process will be nearly 80 million pounds in 1957 (equivalent to over 400,000 tons of sand shells), and that shell moulding will replace half of all sand casting within ten years; although such phenomenal expansion is certainly not anticipated in Great Britain, nevertheless it would appear only a matter of time before shell-moulding becomes an established part of foundry practice in this country.

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* Paper presented at the Fiftieth Annual Meeting of the Institute of British Foundrymen at Blackpool, June, 1953. The Author is attached to Imperial Chemical Industries, Limited.

Shell-moulding Process

Mechanics of the Process

The shell-moulding process is essentially a method of manufacture of sand moulds and cores for foundry casting in the form of relatively thin shells of approximately uniform wall thickness. The process of making such shells is one by which a dry, powdered sand/resin mixture is brought into contact with a heated metal pattern under such conditions that the required thickness of shell is rapidly formed on the pattern, after which the shell is hardened, while still on the pattern, by the application of heat. The hardened shell is then lifted from the pattern. For use as a mould for casting, two such shells are clamped together, cores being inserted where necessary. During casting, the shell moulds may be merely supported by mechanical means to allow the metal to flow correctly through the runners, or, alternatively for certain applications, may be backed with loose granular material.[6]

PROCESS CHARACTERISTICS

To assess the value of the shell-moulding process for foundry use, it is necessary to compare it with the other processes at present available for metal casting.

(*a*) *Range of casting size and dimensions possible.* The shell-moulding process is particularly suited to casting thin sections where high definition is required, for example, air-cooled petrol-engine cylinders. The permeability of mould walls is high, in spite of the use of fine sand in making the shells, since no ramming or densification is employed, and it is, therefore, possible to eliminate gassing difficulties in certain types of castings. For ferrous metals, it is possible to obtain as good results as with die-casting methods for non-ferrous metals. Even for non-ferrous metals,[1] shell-moulding is competitive with plaster or die-casting for mass producing smooth castings which require little or no finishing. As an example of the thinness of castings possible by the shell-moulding process, lettering in both ferrous and non-ferrous metals has been successfully cast with a cross section as small as $\frac{1}{16}$ in.

At the present time, there are definite limits to the production of larger castings by the process. Unless shell wall-thicknesses are used such that the method becomes uneconomical, only a limited weight of molten metal can be supported, although backing of the shell during casting, and cooling of such backing,[6] may do much to increase the limits of size of casting possible, and it has been stated[1, 8] that whereas castings of 20 to 30 lb. in weight were considered an upper limit, castings in excess of 200 lb. are in the making.

It must also be realized that pattern design has to be such that shells can be lifted from the pattern after forming and therefore, although inserts may be placed in the shell moulds that allow undercuts in the final casting, nevertheless, greater intricacy of castings is possible with the lost-wax process. As yet the possibility of moulds made up from more than two shells does not appear to have received attention.

(*b*) *Surface finish*

The shell-moulding process gives high surface finish to castings and reduces finishing operations considerably. This is because it is possible to use sand of finer mesh size than can be employed in normal sand-moulding techniques, at the same time achieving equal permeability. The use of a relatively high binder concentration in the sand holds the fine sand together firmly to give a smooth, hard casting surface to the mould.

(*c*) *Dimensional accuracy*

Castings made by shell-moulding are characterized by sharpness of definition and low tolerances, compared with those made by conventional sand-moulding techniques. Tolerances of 0.003 in. per in. are possible and even closer tolerances are claimed. It should be noted that there is an absence of chilling of metal surfaces cast in shell moulds. On the question of tolerances, the problem of matching up of shells is important and it is obvious that if bowing or distortion of the shell occurs during forming, tolerances will be considerably greater across certain sections of castings. The practice of providing bolt-holes through the shells at a number of points so that the two shell halves may be firmly bolted together will correct minor distortion of shells. If major distortion occurs, this can only be corrected by modification to the basic design of the pattern.

(*d*) *Storage of shell moulds*

Shell moulds can be stored for long periods without apparent deterioration, and the weakening due to moisture absorption or " striking back " observed with many oil- and resin-bound sand cores does not occur in sand shells. Shells that have been stored under normal, dry conditions have shown no visible surface friability after twelve months. The fact that shell moulds can be stored and be immediately available for use at any time is of some importance from the production viewpoint and enables runs of components to be made at short notice.

(*e*) *Economics of shell moulding*

The economics of the shell-moulding process are difficult to assess, and can be considered only in relation to the specific requirements of individual foundries. The basic cost of the sand/resin mixture suitable for shell-moulding is relatively high, of the order of £20 to £30 per ton. Pattern costs are high. Offsetting these is the fact that for both mould and core work, the quantity of sand used is only a fraction of that used by normal sand-moulding techniques. Handling costs are reduced, also fettling and finishing costs. For core work, the rapid-hardening cycle of shell cores means considerable savings in fuel for a given number of components.

Indirect savings will also result from reduction of scrap due to gassing, also tearing on thin sections of castings. For certain applications, quality of castings will justify the higher cost of the mould. Of particular note is the fact that for new production, or where expansion in the foundry is envisaged, both the capital equipment and the foundry space required to introduce shell-moulding for a given volume of work can be considerably less than where conventional sand-moulding techniques are used.

BASIC OPERATION OF THE PROCESS

Raw Materials

The sand required for making sand shells is a fine, dry, silica sand, free from clay and organic impurities, and if necessary sieved to eliminate sea shells and coarse particles. Sand of 100-150 mesh B.S. sieves is desirable; coarser particles than approximately 100 mesh give strength to the shell but mar surface finish and, above 150 mesh, the strength of the shell is decreased without corresponding improvement in surface finish. Redhill "H" grade silica sand, fine Chelford, and other reasonably pure silica sands have been found satisfactory for the process. Experience in the United States confirms the particle-size grading necessary to achieve good results. Independent workers [1, 9] have shown that sand of 151 A.F.S. fineness requires 9 per cent. resin to bond it and gives a very good surface, whereas one of 103 A.F.S. fineness gives a good surface, but only requires 8 per cent. resin to bond. A round, uniformly grained sand of 100 to 150 A.F.S. fineness is sometimes preferred [1, 10]; clay content should be low, the limits given being in one case below 1 per cent. [1, 11], and in another below 3 per cent. [1, 12].

In conventional sand-moulding, the use of additives such as clay, sand, bentonite, coal-dust, etc., to improve specific properties is now established practice. In shell-moulding, the value of ingredients in the mix other than sand and resin binder is still being determined. Plumbago and terra-flake have been proposed [13] to improve the shell surface and increase resistance to metal penetration; inhibitors may be added for light alloy casting. The incorporation of a certain percentage of coarse-grain sand in the mix will improve shell strength without appreciably affecting surface finish; zircon sand is also of advantage to decrease the tendency towards metal penetration.

The type of resin binder most satisfactory to date has been a so-called 2-stage phenolic resin mixed with accelerator, in a finely-powdered condition. This type of resin derives its name from the fact that unlike many other resins used in the foundry, it will only harden when it is heated with the accelerator. Experience has shown that a particle-size of resin somewhat finer than that of the sand gives the best results, too fine a material tending to separate from the sand in the form of dust. This type of resin appears to combine the necessary values for the properties of melting-point, melt viscosity and bonding strength. The particular technical difficulty referred to as "peel-off," *i.e.*, dropping off of the shell during investment when an inverting box is used, is closely bound up with the type of resin employed. Comparative data on two phenolic resin powders, P.F. 422 and P.F. 422/1 have shown that on a particular test pattern over a series of extended trials, the P.F. 422 showed "peel-off" on every occasion whereas the P.F. 422/1, a resin specially modified for use with an inverting box, yielded a satisfactory shell without exception.

Some work has also been done with powdered urea-resin (U.F.) binders, but, to date, phenolic resins of the two-stage type have found most application in shell moulding. To prevent separation of the powdered resin from the sand during moulding operations and to reduce dust, it is now established practice to add a small percentage of either wetting agent or a liquid phenolic resin to the mix.

Mixing

For ferrous casting, the following proportions of sand and resin binder are in general satisfactory for shell forming:—

Dry silica sand, 100 parts by weight.

Powdered phenolic resin binder, 6 to 8 parts by weight.

The actual amounts must depend on the particular sand and resin binder used, and for non-ferrous casting it should be possible in certain designs to reduce the resin content appreciably. It is found that, with a given sand and resin binder, the surface finish of the shell varies little with different resin contents within the range under consideration, but, on the other hand, both the compression and tensile strengths of the shell and the surface friability property depend on the binder content of the mix.

Actual test results obtained for shell mixes containing different quantities of resin are given in Table I.

TABLE I.—*Compression and Tensile Strengths of Dry Sand/Resin Mixtures for Shell-process Moulding.*

Resin: P.F. 422 (phenolic, two-stage, powder resin passing 100-mesh sieve).
Sand: Fine silica sand.
Resin percentage on sand: 6 and 10 per cent.
Test Samples (specimens moulded without ramming or densification (*a*) compression: cylindrical 0.53 in. dia. by 0.5 in. length; (*b*) tensile: A.F.S. tensile core specimen (dumb-bell).
Hardening temperature: 232 deg. C.

Resin percentage on 100 per cent sand	0	6	10
Compression strength (lb. per sq. in.) ..	0	1,140	2,500
Tensile strength (lb. per sq. in.)	0	230	400

It is essential, during mixing, to ensure that the resin binder is dispersed uniformly throughout the sand; local concentrations of resin in the shell will give resin "spots," which can be responsible for gassing during casting. For mixing, a rotating tumbling-type mixer is preferable to conventional foundry sand mixers, which are liable to deposit unmixed material on the bottom and sides of the mixer and round the blades. Secondly, the powdered resin, which is normally supplied in moisture-proof containers, should not be allowed to stand in contact with the air for undue periods before mixing, since it will exhibit a tendency towards "balling," due to absorption of moisture-vapour from the air. Such "balls" or lumps will normally break down readily on mixing, unless the resin has been too long exposed to the air, when hard lumps, difficult to disperse in the sand, will be formed, giving rise to resin "spots" in the shell. It is wise not to allow the temperature during mixing to rise above 50 deg. C. and hot sand from the dryer must not be used, as is sometimes the practice in normal core-sand mixing. Once mixed, the product will

Shell-moulding Practice

store for reasonable periods in a normal dry atmosphere.

Other ingredients in the mix, such as wetting agent or a liquid resin, may be added, and it is recommended that they should be first mixed with the sand to wet the surface uniformly, and the powdered resin binder then added.

Lubrication of the Pattern

Without pattern lubricant, the hardened shell will adhere firmly to the pattern and be irremovable without fracture. In general, cast iron has been found the most satisfactory pattern metal, although aluminium and non-ferrous alloys and steel have been used. An essential is that the pattern should withstand temperatures of up to approximately 400 deg. C. without melting or warping. Low-expansion metals have obvious advantages in maintaining close tolerances. The possibility of corrosion during use of aluminium and other non-ferrous alloys must be taken into account.

For lubrication, separating agents based on silicone resins have been found most generally acceptable. Examples are silicone oil F.115, which is a clear liquid suitable for brushing and spraying, silicone grease D.C.7, which is a grease suitable for wiping over the pattern surface, or silicone emulsions. In the United States, the literature indicates that there is a preference for emulsions, but comparative tests the Author has done suggest that the oils and greases give a more continuous film on the pattern with improved covering power, whereas the emulsions tend to deposit the silicone resin in discrete particles. If the pattern is given two or three pre-treatments with the silicone separating agent, each application being baked on the pattern at 200 to 300 deg. C., then a semi-permanent lubricating surface is built-up, from which a considerable number of shells can be lifted with only occasional lubrication between operations. A more economic separating fluid can be prepared from silicone oils by dilution with solvent.

An alternative grease for pattern lubrication is "Gargoyle H.T." grease, which is both very effective and economic in use. Polytetrafluorethylene (P.T.F.E.) gives a good permanent lubricating surface to the pattern, but present supplies are insufficient. Montan and other waxes have also been proposed for pattern lubrication.[7] To effect separation of the shell after hardening, adequate ejector pins or plates on the pattern are essential.

Pattern and Oven Temperatures

Pattern temperatures ranging from 150 to 300 deg. C. have been recommended in literature on the process, but actual pattern temperature must depend on design of the pattern and type of resin binder used. High pattern-temperatures give faster build-up of the shell and decrease hardening time, although the latter can be controlled by oven temperature. On patterns where design is such that both heavy and light sections are present, the use of high pattern-temperature will give very rapid build-up and hardening on the heavy parts at the expense of the light sections during a given investment and oven time, so that there may be a tendency to over-cure the shell on the heavy parts and insufficiently cure the shell on the lighter sections. Alternatively, a low pattern-temperature, combined with a high oven-temperature can cause burning of thin sections protruding from the shell.

In general, a pattern temperature of 200 to 250 deg. C. has been found most useful, with an oven temperature of approximately 300 deg. C. It is found that such a system allows for continuous operation on most types of work, the pattern temperature being maintained reasonably steady during working. For rapid production of shells, a comparatively low pattern-temperature (200 deg. C.) has been used in combination with a high oven-temperature (400 deg. C.).

Investment Time

When an inverting box is used for shell forming, the investment or build-up time of the shell depends on (*a*) the thickness of shell required, (*b*) the temperature of the pattern, (*c*) the thickness of the pattern. In general, a minimum thickness of pattern desirable is ½ in., although it must be realized that many sections on the pattern, for example the fins in an air-cooled petrol-engine cylinder or the stem of an engine valve, will be below this thickness.

The temperature of the pattern has considerable effect on the rate of build-up of shell, this being illustrated by the following published data[11]:—

Pattern: Cast iron.
Thickness of shell build-up:—$\frac{3}{16}$ in.

Temperature, deg. C.	149	177	204	232
Time required (seconds) ..	21	12	10	7

At pattern temperatures of 200 to 250 deg. C., the time to build-up a production shell usually lies between 10 and 25 secs., depending on the thickness required.

Hardening Time

Where oven heating is used to harden the shell, hardening time depends on (*a*) oven temperature, (*b*) pattern temperature, and (*c*) thickness of shell. At a pattern temperature of 200 to 250 deg. C. and an oven temperature of 300 deg. C., hardening time usually lies between one and four min. Higher oven-temperatures, as indicated earlier, will reduce shell hardening time. A total cycle time of as low as 1 to 1½ min. has been claimed[3] although in this case no temperature details are given.

Methods for Producing Sand Shells

For small and medium-size shells, the inverting box is the most important method for formation. The inverting box is in principle a metal or wooden box, open at one end, that holds the sand/resin mix. The heated pattern is clamped over the open end and the box inverted to allow the sand/resin mix to fall on to the pattern face. After a predetermined time, the box is righted, excess sand/resin mix falls back into the box and the pattern is lifted off, with the soft sand shell adhering to it. The pattern and shell are then submitted to oven treatment for a predetermined time at the end of which the hardened shell is ejected from the pattern. The pattern is immediately clamped on the inverting box again and the cycle repeated. The same principle can be used with the pattern clamped and unloaded from the lower end of the box employing a suitable sand trap inside the box. This obviates the necessity for turning the pattern over at the baking stage, and eliminates "peel-off" difficulties that may be met.

Alternative methods of producing the shell, applicable for larger shells, is by hand dispensation or by the use of a perforated "peper-pot." The sand/resin mixture can also be applied to the pattern by blowing, and it is when using this technique that wetting agents in the mix become of value in preventing separation of the lighter resin component from the sand. Cores may be produced by tumbling or blowing the sand/resin mix into a hollow vessel, and apparatus for this process has been the subject of claims.[5]

For hardening larger shells, methods must differ from those used for hardening small moulds, where patterns with their adhering shells can be lifted into an oven. Mechanization of the process will allow large patterns to be invested and then transferred through a continuous oven without manual operation. Alternatively, infra-red heating may be applied, or the pattern may be electrically heated.

Casting of Metals in Shell Moulds

Casting moulds are made by clamping together two, or possibly more shells and cores can be inserted in the assembly. In practice, spring- or screw-clamps can be used, but bolt-holes through the shells are preferable, since, as indicated earlier, bowing or distortion of shells can be corrected by the use of suitably positioned bolts. Location pins and holes may be formed as part of the actual shell. As an alternative to mechanical fixing, it should be possible to glue the shell halves together and developments are envisaged to evolve satisfactory techniques based on synthetic-resin glues.

During casting of metal in the shell mould, gases are immediately evolved through the back of the shell and, within seconds, the shell darkens as the binder begins to decompose. Breakdown is rapid and in most cases complete, but it may be observed that the edges of the mould are not broken down, indicating a low rate of heat-transfer through the shell material. This is to be expected, taking into account the open or cellular structure of the shell. The recovered sand from shells after casting is not suitable for re-use in the shell process.

The shell process has been found suitable, with little modification to basic mixes, for casting iron and aluminium. Steel has been cast successfully although it has been reported[1,9] that impellers with knife-edges cast in shell moulds had shrinkages in the impeller hub, and that knife-edges were incompletely filled when stainless steel was used, whereas aluminium, bronze and cast iron were satisfactory. Another report[1,9] states that shell-moulding is particularly suited to aluminium, grey, nodular and malleable iron, low-lead low-tin bronzes and high-alloy steels. Lead sweating of high-lead bronzes continues to be a problem. Preliminary work with magnesium, incorporating oxidation inhibitors, has been promising. In the successful Danish production trials discussed earlier in this paper[4] the composition of the iron was as follows:—Carbon 3.1 to 3.3 per cent.; silicon 2.0 to 2.2 per cent.; manganese 0.6 to 0.7 per cent.; sulphur 0.08 to 0.11 per cent. and phosphorus 0.2 to 0.25 per cent., with a Brinell hardness (on flange) of 200 to 240. It was also mentioned earlier[3] that a number of components, including camshafts, crankshafts and exhaust valves were now in production using the shell process at Ford Motor Company, U.S.A. In Great Britain, initial production experience has been mainly with iron and aluminium, and these metals have been cast successfully in a number of foundries. Results with brass, bronze and gun-metal have been varied and there is no doubt that much production experience remains to be built-up in the foundry on different metals. Carbon pick-up of low-carbon steels remains a problem.

Conclusion

A considerable background has been built up on the shell-moulding process, and satisfactory techniques both for the making of shells and for casting into them have been established. Factors such as influence of sand particle-size, and type of resin binder on shell properties, separating agents, pattern materials and pattern and oven temperature have been investigated, and many data are now available. The main advantages of the shell-moulding process over conventional sand-moulding techniques are (*a*) superior finish of castings, (*b*) closer tolerances on casting (*c*) ease of casting thin sections (*d*) lowered surface chilling of metals (*e*) reduction of blowing and (*f*) reduced after-machining costs. These properties are of particular interest to the motor and aircraft industries, for the casting of engine components, and it is in these industries that the most rapid progress is expected in applying shell-moulding. For more general foundry work, requirements differ from foundry to foundry. Reduction of finishing costs and of reject rates on certain types of castings can more than offset higher moulding costs, without taking into account the other advantages offered. Size of castings is, to date, a limiting factor, and in addition the type of individual work done by many jobbing foundries is not suited to shell-moulding. It is expected, therefore, that the process will become established firmly in the petrol and Diesel-engine industries and will be used on a considerable scale for all types of precision components; that in a number of industries, for example textile machinery, pumping equipment, electrical components etc., it will be utilized for a wide variety of specialized casting requirements; and that in jobbing foundries, making larger castings for heavy machinery and equipment, it will find comparatively little application.

Shell-moulding Practice

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[*See also discussion, p.* 541 *of this issue.*—EDITOR.]

Correspondence

MASTER PATTERNMAKERS' ASSOCIATION?

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—I have read with much interest your Leader article in the current issue of the above Journal, relating to the formation of a Master Patternmakers' Association. There is very sound common sense in all you say, and I am writing to state that this company would very much like to be kept posted of any progress, so that the joining of such an association can be fully considered.—Yours, etc.,

J. F. BOWERS,
General Manager.

Harvey & Longstaffe, Limited,
Manchester, 4.
October 23, 1953.

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—Your leader regarding the formation of a Master Patternmakers' Association contains not merely a sensible suggestion but also a generous offer of help to the parties who should be interested.

If there are other master patternmakers of similar mind to my own who would be ready to join in an initial personal discussion on the ways and means of getting an organization into being, I would be very pleased to hear from them with the object of pursuing the matter further.

Whilst the larger patternmaking firms are particularly invited to comment, I am of the opinion that every established patternmaking concern should have something in common on the points already indicated in your leader, and it is my opinion that none of these firms should consider itself too big or too small to participate in a trade association having the welfare of all as its main objective.

Undoubtedly, the project would involve an expenditure of time and money on the part of the members of the suggested organization, which may not necessarily be immediately compensated. On the other hand, one must face the fact that a truly representative trade organization adds prestige to its members by the unification of broad principles, and the benefits are most likely to be of a long-term rather than a short-term nature.

Yours, etc.,
B. LEVY,

B. Levy & Company (Patterns), Limited,
Westminster, London, S.W.1.
October 26, 1953.

Death of Eugen Piwowarsky

Dr. J. G. Pearce writes:—

Scientific metallurgy in general and foundry metallurgy in particular have suffered a considerable loss by the death, at his home in Aachen on October 17, 1953, of Professor E. Piwowarsky. He was born in Upper Silesia on November 10, 1891, educated at the Technical High School, Breslau, where he was lecturer until 1922, when he left to take a post at the Technical High School, Aachen. There he remained for the rest of his working life, and he died in harness.

At the time of his appointment to the second of the two professorships of metallurgy at Aachen, his interests were in general metallurgy, but the cast metals soon claimed his attention, and the work for which he is perhaps best known abroad, on superheating cast iron melts, was published in 1925. In 1928 he set up a special department for foundry engineers, and in essence converted his chair into one exclusively concerned with the cast metals, ferrous and non-ferrous. To house the school he created, he established the Foundry Institute of the University, of which he was director as well as professor of metallurgy. Piwowarsky saw, quite correctly, that the training of the foundry technologist to-day can be based on a body of scientific knowledge of such size and of such varied character as to constitute an academic discipline justifying a degree course of its own.

In 1929, Piwowarsky published a text book on high-duty cast iron, which went into a second edition in 1942. The revised version of this, 1951, under the simple title, " Cast Iron," is a volume of over 1,000 pages, three-quarters of it purely metallurgical. In it he drew heavily on the work of his own Institute, and if it betrays (due to the war period) some lack of contact with work in other countries and of the exercise of a fuller critical sense which would have reduced its bulk and increased its value, it remains a monumental work, the most comprehensive on the material in any language.

In addition to the work mentioned, he did much on the cupola furnace, and his work on alloying elements on growth and on wear of cast iron is also well known.

Many foundrymen outside Germany will recall his approachability, gaiety of spirit and social charm, for he represented that country at many international gatherings. He was highly respected in the University and enormously popular with his students, the successive generations of which became, under his inspiration, the Aachen Foundry Family, which has an annual reunion. In August, 1951, the writer, after visiting some German foundries, joined his group of final-year students for their annual visits. In a strenuous programme through nine establishments in the Saar and lower Rhine, with plain living and austere sleeping. " Piwo," as he was affectionately called, fully participated. This tour, incidentally, served to show the extent to which he was supported by the foundry industry.

During the war Aachen suffered severely and the Institute was damaged. Of the two-thirds of the University destroyed, only one-third has so far been rebuilt. It was mainly due to Piwowarsky's efforts that the new Institute was designed, built and equipped, at a cost of over a quarter of a million sterling. It was opened in 1952, and is a six-storey building forming an impressive architectural feature of the ancient city of Charlemagne. Sincere condolences will be accorded by foundrymen everywhere to his widow in her sad loss and to his friends and colleagues.

Whiteheart Malleable Annealing

Developments at H. & J. Hill (Willenhall) Limited

With the installation of a standard Birlec 300-kw. elevator-type electric malleablizing furnace, the old-established malleable castings concern of H. & J. Hill (Willenhall), Limited, near Wolverhampton, Staffs, are now employing flow-production methods in their annealing section. The furnace follows the same design as the standard unit described in the article "Gaseous Annealing of Malleable Castings," published in our issue of December 27, 1951. It has been installed in a modified foundry building, from which the first floor has been removed to provide head room. Apart from shotblasting plant equipment at one end of the shop, this building is entirely taken up by the annealing furnace and its associated equipment, leaving ample space for loading and unloading the bogie hearths and the sorting of the castings after annealing. This arrangement enables full advantage to be taken of the inherent cleanliness of the process and provides excellent working conditions. The electrical equipment is all housed in an annexe to the annealing shop and the Visco water-cooling plant, dealing with 3,000 gall. per hr., is located near the furnace.

Work Arrangement

As suppliers of malleable castings for the general-engineering industries, H. & J. Hill, Limited, handle work which varies considerably in weight, dimensions and section. In particular, large quantities of components weighing only an ounce or two are processed. The annealing work is all handled by girls, supervised by one man who manages the complete furnace installation. A normal day-time shift is worked, no night or week-end work being necessary. This arrangement has been facilitated by the installation of a simple conveyor system on which the castings are carried in easily-handled pans which travel along the roller conveyor from the shotblast plant to a position where the contents are inspected and fettled. On being unloaded, the castings are again sorted into

TABLE I.—*Charge-cycle Data for Whiteheart Annealing.*

	First charge.		Second charge.		Third charge.	
	Time/date.	Hours.	Time/date.	Hours.	Time/date.	Hours.
Load charged	18.30/1 ..	—	18.00/5 ..	—	18.30/9 ..	—
Charge reached 1,050 deg. C. ..	04.15/2 ..	9¾	03.30/6 ..	9½	04.45/10 ..	10¼
Soaking at 1,050 deg. until ..	17.15/4 ..	61	18.15/8 ..	62¾	17.00/12 ..	60¼
Rapid cooling at 410 deg. to	23.15/4 ..	6	23.59/8 ..	5¾	23.59/12 ..	7
Reheating to 790 deg. C. to	06.00/5 ..	6¾	09.00/9 ..	9	09.00/13 ..	9
Slow cooling to 700 deg. C. to ..	15.45/5 ..	9¾	14.30/9 ..	7½	18.30/13 ..	9½
Rapid cooling to discharge	17.45/5 ..	2	16.00/9 ..	1½	19.15/13 ..	¾
Total time		95¼		96		96¾

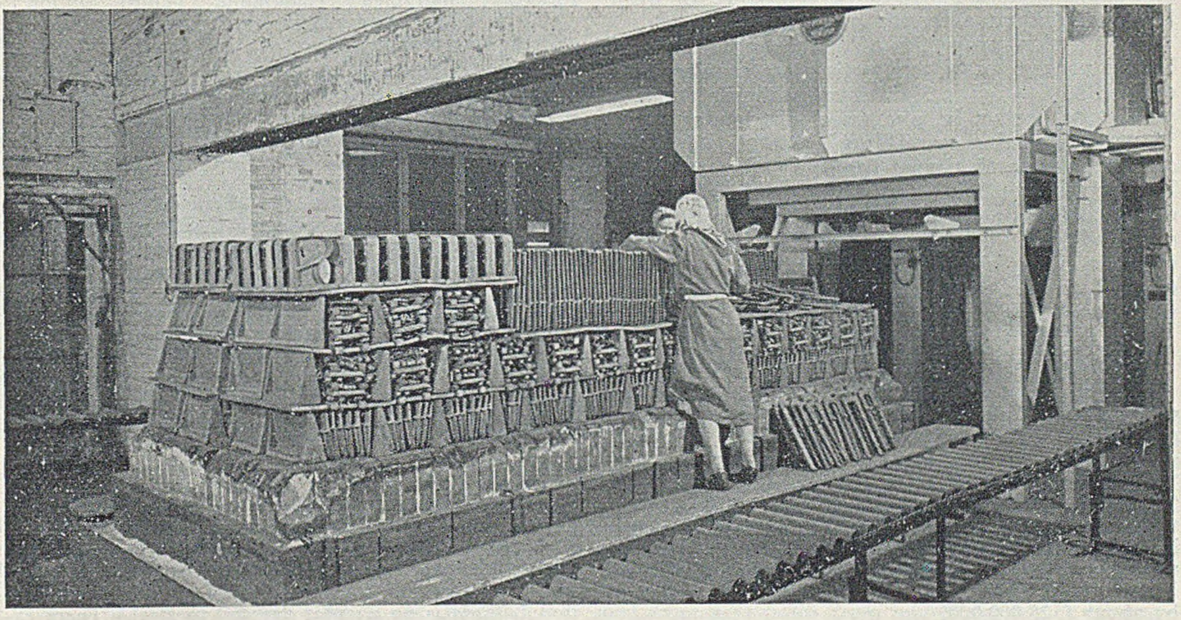


FIG. 1.—*Electric Elevator-type Annealing Furnace newly installed by H. & J. Hill (Willenhall), Limited. Girl Operators are shown loading a Furnace Bogie with Castings brought to them on Roller Conveyors.*

pans and placed on the roller conveyor as soon as possible to minimize unnecessary lifting. This conveyor leads through a trap in the wall of the annealing shop, from where it continues across an opening to the dressing shop and despatch department.

A 96-hr. heat-treatment cycle has been adopted as standard, and there is very little variation from this. The timings of three typical successive heats demonstrate this, see Table I.

In each case, the net charge weighed between 6½ and 8 tons; the heating time, cooling and reheating periods varied slightly with such factors as the weight and density of the charge, and the furnace temperature when the charge was loaded.

Advantages

The adoption of this standard cycle results in pronounced operating advantages. Foremost is the fact that the furnace heating-up period, after the charge has been loaded at about 6.30 in the evening, always takes place when reduced electricity tariff rates are in operation. Unloading the previous charge at this time, also, gives it the night-time to cool down, ready for the operators to unload next morning. An easily-understood, readily-repeatable cycle, also simplifies annealing procedure and enables significant comparisons to be made. Although meter readings for the total factory consumption are taken at the end of each annealing cycle, accurate data on electric power used are not yet available as the annealing equipment is not separately metered. On the three heats referred to above, however, it is estimated that, allowing for other electricity usage, the consumption approximated 10,000 units per charge, or from 1,250 to 1,400 units per ton of castings.

The physical properties of the castings, annealed by this process, more than satisfy the requirements of B.S.S. 309—Grade 2, an average tensile strength of 28 tons per sq. in. and an elongation of 12 to 15 per cent. being readily achieved. Castings are selected from each charge for destruction tests, the heavier sections being tested for machinability by drilling. On one occasion, a 4-in. cube casting was annealed and used as a test-piece, satisfactory evidence being obtained by this rough and ready method that complete malleablization had taken place, even in the thickest section.

Engineers Wage Claim Rejected

The Executive Council of the Confederation of Shipbuilding and Engineering Unions met at York last week to consider its next step following the decision of the Engineering and Allied Employers' National Federation to reject outright the confederation's claim for a 15 per cent. increase on the consolidated time rates of all adult male workers in the engineering industry. About 2,500,000 workers are affected by the claim; it is estimated that, if granted in full, it would increase the wage bill of the industry by about £125,000,000.

It is understood that 93 per cent. of the members of the employers' federation were in favour of uncompromising rejection of the claim.

Publications Received

An Introduction to Amides, Nitriles, Amines, Quaternary Ammonium Salts; their manufacture, properties and Applications. Published by Guest Industrials, Limited, 81, Gracechurch Street, London, E.C.3.

Initially the reviewer was "flummoxed" with the formula for lauric acid which reads:— $CH_3\ CH_2\ CH_2\ CH_2\ CH_2\ CH_2 CH_2\ CH_2\ CH_2\ CH_2 CH_2\ COOH$. However, under Metallurgical Industry," the Querton group, Amine HPL, OL and their acetates are recommended to inhibit iron corrosion by acid solutions, such as pickling baths, etc. This catalogue is available to our readers on writing to Gracechurch Street.

Aluminium Panorama. Published by Aluminium Limited, Montreal, Canada.

This beautiful book, of superb binding and magnificent illustration, tells the history of the formation and subsequent world-wide development of Aluminium, Limited. Yet it is no dry-as-dust recapitulation of facts and figures, but an interesting and colourful account of the countries in which the company operates, plus, of course, the activities of the concern. Mining is undertaken in Canada, British Guiana, Jamaica, the West Coast of Africa and Brazil; smelting in Great Britain, France, South Africa, Japan, India and Australia, and sales in many places. The book thus gives an interesting survey of the whole of the free world. Recipients can indeed count themselves fortunate. The company is in the middle of a four-year expansion programme which includes the installation of 1,000,000 h.p. of new hydro-electric generating capacity in British Columbia and Quebec. Further, it involves the establishment in Canada of new smelting capacity for an additional 150,000 metric tons. The company's associates in Britain include the Northern Aluminium Company with factories at Handsworth and Banbury.

Foseco Foundrymen's Handbook. (Third Edition.) Issued by Foundry Services, Limited, Long Acre, Birmingham, 7. Price 8s., post free.

The first item the reviewer noticed in this compendium was the table for converting degrees centigrade into Fahrenheit, or vice versa. This is excellent as one uses the central column and looks left or right according to the scale sought. There are no fewer than 80 pages in Section I, which contains the normal type of information a foundry foreman requires in his day-to-day work. The four following sections each have their own special appeal. Section II deals with light alloys and opens up with seven pages of specifications. Later, melting procedures are recommended, using the issuing houses proprietory material. Section III is badly captioned as "Non-ferrous Casting Alloys." It should read "Other Non-ferrous Alloys," as light alloys enter into this category. Here again, though not quite so lengthy, a start is made by listing the B.S. specifications for copper-base alloys, followed by much sound advice. Section IV, "Iron Castings," soon carries a table of suggested compositions, obviously culled from an American source. By and large, castings in this country can be made a little harder for the same purposes as against American practice. In this section there is, strangely enough, no mention of malleable iron. Moreover, whilst some useful information is given amongst the tables of Section I, there is no chapter devoted to steel. There is, however, a valuable section covering die-castings. This is an extremely useful book, which will be greatly valued as a handy and reliable source of current data.

Cupola Spark and Dust Arresters

Roper Equipment at Grahamston Iron Company

With the increase in agitation throughout the country for the prevention of atmospheric pollution, founders are paying greater attention to suppressing solid and gaseous effluent from their cupolas and this account of new equipment installed at Grahamston Iron Company, Limited, Falkirk, is typical of steps being taken to combat the nuisance.

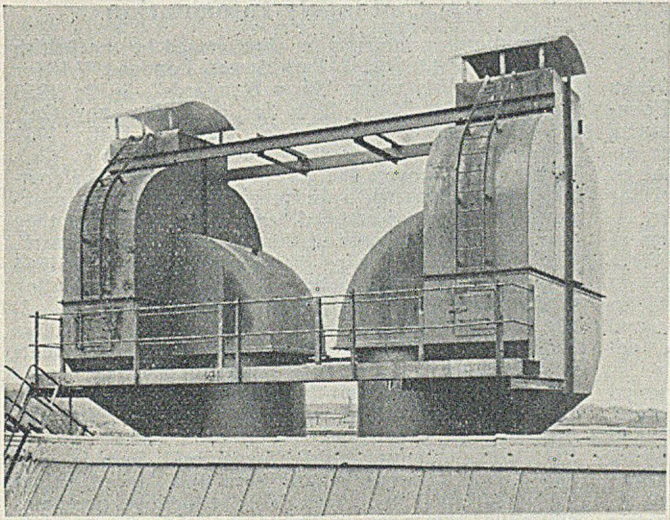
Two views of spark- and dust-arrester equipment manufactured by E. A. Roper & Company, Limited, and installed at Grahamston foundry are shown in Figs. 1 and 2. The installation caters for a pair of 6 ft. dia. cupolas lined down to melt 8 tons per hour each. The collectors are designed on the expansion-chamber principle, with side flues. The velocity of cupola waste gases passing through is reduced to such an extent that any solid material and even quite fine dust in suspension falls by gravity into the collector and is self discharged from an outlet at the bottom by a pipe reaching to platform or floor level.

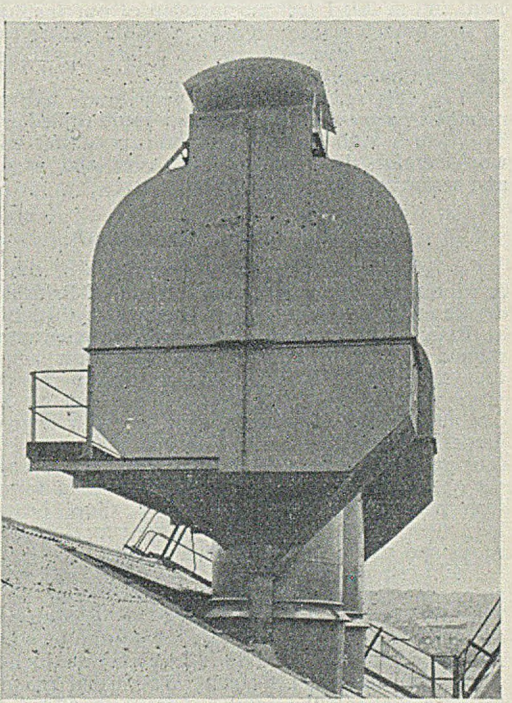
The equipment was first designed during the war for anti-glare purposes; it proved so lastingly successful as a dust arrester, however, that it has since been developed for this purpose and there are several in operation in various parts of the country. The plant is constructed of substantial sheet steel and is lined throughout with firebrick, giving adequate protection from the heat during cupola operation and particularly at the blowing-down period.

Results

The amount of arrested material seems to vary very considerably; to a large extent it seems to be dependent upon the degree of sand contamination on the pig and particularly the return scrap of the cupola charge. During one day's blow, however, at Grahamston Foundry, 11¾ cwt. of ash and other particles were collected, over a melt of 52 tons, and an average of 10 cwt. for a 50-ton blow has been recorded. It will be appreciated that at the Grahamstown foundry men previously employed cleaning the roofing gutters of the factory are now free for productive work. Among other firms who weigh the refuse from these spark arresters and one foundry reports that they collect an average of 1½-cwt. of ash per 12-ton blow, the firm being malleable iron-founders making pipe fittings. A large percentage of the material collected is fine dust and will pass through a 60-s G screen. Other interesting data reported is the case of a local foundry. This works is completely surrounded by private housing property and there has been in the past a considerable number of complaints in connection with the dust, sparks and smoke during blowing times. Since adding the spark arrester, no further complaints have been received. To give readers a further idea of the volume of material collected, the density of ash in one particular installation was found to be 40 lb. per cub. ft. (in the dry state).

It would appear that the double purpose of saving in roof-glass cleaning and minimizing local atmospheric pollution is well served by such installations.





FIGS. 1 AND 2.—*Two views of the Roper-design Twin Spark- and Dust-arrester Equipment fitted to 6 ft. dia. Cupolas at the Foundry of Grahamston Iron Company, Limited. Note the Catwalks and Inspection Doors provided.*

THE PRICE for antimony ore was advanced by 2s. last Monday to range 22s. to 24s. (nominal) per unit, c.i.f.

EXPORTS OF SCRAP from Germany rose to 110,000 tons in September from 70,000 tons in August and only 26,000 tons in July.

THE STORA KOPPARBERGS BERGSLAGS AKTIEBOLAG (Sweden) announces that they have discovered 19 new new iron-ore deposits in the Amal Edsleskog and Mo districts. All these deposits are considered workable.

THERE WILL BE no compulsory load-spreading scheme for the Midlands during the winter, the Midland Regional Board for Industry announced last week Industrial power consumers have, however, been asked to co-operate voluntarily by helping to remove the load from peak hours from mid-November to the end of June, if possible, by a 10 per cent. reduction. Firms with private generating plants have been asked to use them to the full during peak hours.

Notes from the Branches

Lincolnshire

Members of the Lincolnshire branch of the Institute of British Foundrymen spent a very interesting afternoon recently, visiting the Beevor foundry of Ruston & Hornsby, Limited. In the evening of the same day, the inaugural meeting of the session was held, at which the new president, Mr. D. Killingworth, gave his address.

Dealing with changing conditions in foundries, consequent upon our embarkation upon the "Atomic Age," Mr. Killingworth included in his remarks the following:—

"Founding to-day, even with all its mechanical aids and scientific controls, is still an art, and human operatives are engaged at almost every stage both in management and on the floor. I hold firmly to the opinion that it is the spiritual and mental outlook of all engaged that will control the quality and progress and provide the urge to improve products and heighten achievements.

"Material incentives are already being given and improvements based on the 'Garrett Report' will provide for physical health and well being, but to these must be added the highest motives of human endeavour and pride in pure achievement if we are to prosper. This cannot be bought or supplied, but can only grow from within. It can be fed by example and by infection, and in this I feel membership of our Institute and of our branch is a great help. As we gather together to discuss our successes and to defeat our failures, so the infectious spirit spreads.

"For this reason I would very much like to see membership grow to include many more skilled artisans. They are a vital part of our industry, and I am sure would enrich the store of knowledge and experience and at the same time benefit themselves."

Wales and Monmouth

On Saturday, September 19, members of the Wales & Monmouth branch of the Institute of British Foundrymen visited the works of Stothert & Pitt, Limited, at Bath. Unfortunately the excellent programme arranged had to be curtailed owing to late arrival of the train, which was delayed at Severn Tunnel for more than an hour. The party was met by Mr. A. Corbitt, welfare supervisor, together with a group of guides. Owing to the late start, tea was served before touring the works. Visitors were then arranged in six groups of ten members and proceeded to visit in turn patternshop, foundry, fettling shop, heavy and light machine-shops, fitting and structural shops, tool room and pump-assembly department.

Each group being in charge of a well-informed guide, any queries arising were dealt with *en route*. The variety of work in course of production and assembly made the tour one of continuous interest. At the conclusion, Mr. G. Mackinlay, branch president, thanked Major General Watkinson, the managing director, for the firm's courtesy in affording this opportunity of visiting the works. His presence to greet the visitors was appreciated and the president was sure that every one had enjoyed a very interesting afternoon. Major General Watkinson, in reply, said his firm were always ready to encourage visits from Institutes such as that of the foundrymen, and he was pleased to welcome them on this occasion. He hoped that they had seen much of interest during the tour.

The Wales and Monmouth branch opened their lecture session on October 3 with a film display, "Lloyds Nowadays," at the Engineers' Institute, Cardiff. Mr. J. Mackinlay opened the proceedings and introduced Mr. Tranter, a member of the technical staff of F. H. Lloyd & Company who had kindly come down to answer any query that might arise.

Replying to a question from Mr. Watson, Mr. Tranter gave the ramming capacity of the large impeller-type ramming machine as 18 cwt. per min. Facing sand was placed in position, he said, and backing sand only was rammed by the machine, the latter being done after preliminary preparation by skilled moulders. Other questions, on production control, gating and feeding, and planning committees, were dealt with satisfactorily.

Moving a vote of thanks, Mr. Croxford first praised the film, which illustrated the whole progress of production at a modern steel foundry, and then complimented Mr. Tranter on his handling of questions from every angle in a most satisfactory manner. Mr. Watson, in seconding the vote, referred to the film as probably the best technical film of a steel foundry. Mr. Tranter briefly acknowledged these remarks on behalf of his firm and himself.

East Midlands branch—Northampton Section

The second meeting of the Northampton section of the East Midlands branch of the Institute of British Foundries was held on October 15 at the Hind Hotel, Wellingborough, and was attended by over 60 members and guests. The evening was devoted to the showing of two films: "Plan for a Foundry" (Ford Motor Company, Limited) and "All Star Casting" (F. H. Lloyd & Company, Limited). Mr. Ben Hird presided and welcomed Mr. H. Pinchin, president of the East Midlands branch.

B.S.I. Monthly Information

The monthly information sheet issued by the British Standards Institution, 2 Park Street, London. W.1, for September, lists under "New Standards", 2030: 1953 Dimensions of X-ray films for crystallography (2s.), and under "revised standards" there is, 1548: 1953 certified samples for metallurgical analysis (2s.). This standard covers the general conditions to be complied with in regard to the preparation, analysis, packing and storage of certified samples, in order that they may qualify for the use of the B.S.I. certification mark. Under "amendment slips" there are B.S. No. 416: 1944 cast-iron spigot and socket soil, waste and ventilating pipes, fittings and accessories (amendment No. 3) PD 1691; 1250 Pt. 2: 1946 Domestic gas appliances for immediate post-war housing. Detailed requirements in regard to cookers, water heaters, gas fires, space heaters and refrigerators (amendment No. 2) PD 1682; L 100: 1951 inspection and testing. procedure for aluminium and aluminium alloys (amendment No. 1) PD 1676. "Future publications" will include B.S. 2035: 1953 cast-iron flanged pipes and flanged fittings (6s.), and the list of "standards withdrawn" contains 1007: 1942 summary of British and American specifications for non-ferrous metals and, 1111: 1943 summary of British and American standard specifications for iron and steel. B.S. 427: 1931 tables of diamond pyramid hardness numbers (3s.), has been reprinted.

"Draft standards circulated for comment" include CR 5139 method for the determination of silica in blast-furnace slag Method for the determination of aluminium in iron, steel and ferro-alloys after mercury-cathode separation; and CR 5205 method for the determination of iron in aluminium (volumetric-titanous chloride method).

British and American Shell-moulding Practice

Joint Discussion of Papers by B. N. Ames and D. N. Buttrey

This discussion was undoubtedly the most interesting of the whole conference and was indicative of the ferment throughout the industry as a result of the introduction of shell-moulding. Seriatim, such things as the necessity or otherwise for backing; optimum shell thickness; methods of mounting for casting; sand properties; overseas practice; perspective viewpoint of the process, coremaking, carbon pick-up and comparative costs were dealt with. For the purpose of preserving continuity, the written replies of the American Author, Mr. Ames, have been inserted in the report where appropriate, although, of course, they were obtained subsequent to the meeting.

Two Papers representing British and American views on shell-moulding practice were discussed jointly at the first technical session of the fiftieth annual conference of the Institute of British Foundrymen in Blackpool, Mr. Longden, the president, being in the chair.

Formally opening the meeting, the CHAIRMAN said that of the two papers for consideration, the first was the American Foundrymen's Society Exchange Paper "Survey of the Shell-moulding Method of Casting Production,"* by Mr. B. N. Ames, and the second, "Shell-moulding Process,"† was presented by Mr. D. N. Buttrey, M.SC. The two papers would be given and then he proposed a joint discussion on both. The American Exchange Paper was taken first and he called on Mr. Hallett, well known to members through his own contributions to foundry technology, to present it in the absence of the Author.

Mr. M. M. HALLETT said he approached the task of presenting the Paper with some trepidation, because he had not had an opportunity of seeing Mr. Ames or of discussing the Paper with him. However, if members read the paper they would find it so clear that there would be no difficult points in it. It was an admirable Paper and was based on the practice of the American Naval Shipyard, but it represented Mr. Ames's personal opinions and should not be taken as an official statement of the practice of the Navy Department of the United States.

THE PRESIDENT next called on Mr. D. N. Buttrey, M.SC., to present his paper, and afterwards opened the meeting for discussion.

Is Backing Necessary?

MR. A. DUNLOP, who began, said there was quite a difference of opinion in this country on the actual way a shell should be backed up. Certainly, in America he believed they practised backing up and they did so in Germany also. When shells were not backed, they had to be thicker and, while the expense and cost of equipment to back up might appear to be high, it was just possible in the long run that backing up and using thinner shells would prove more economical. As an example, he had in mind the cost of a shell made $\frac{3}{8}$ in. thick and not backed up, as compared with a shell made $\frac{3}{16}$ in. thick, which would need backing. Both shells measured 28 by 16 in. The difference in cost of producing 100 such shells was 42s.—a sum that would go a long way towards paying for the backing up.

Another point also referred to the economy of thickness of shell. While the process could be worked by semi-skilled labour and was simple in application, a very slight variation in investment time could result in a slight difference in the thickness of shell, and that difference in shell thickness could represent quite a costly item on shells of the type to which he had already referred. If the investment time varied from 7 to 10 secs., which was not very long for a machine, the variation in price would be 5s., so that, on a long production run, the difference on the cost of 100 shells could be considerable. When, recently, he had showed some shells he had made to a German visitor, that gentleman had been shocked at the thickness of shell and had said in his country they could not afford to make shells so thick—it paid better to back them up.

MR. HALLETT, commenting on Mr. Dunlop's second example, said that the quoted dwell time of 7 to 10 secs. was shorter than normal, so that a variation of 3 secs. was more important than it would be in the usual dwell time of 15 to 30 secs. In any case, a properly-trained operator with a seconds clock in front of him should not vary the time by 3 secs.

The AUTHOR, MR. B. N. AMES, wrote subsequently that he concurred with Mr. Hallett's comments regarding the variation in setting time with a manual operation. With a conscientious operator it was entirely possible to produce quite uniform shell thicknesses. In many cases, the temperature of the pattern plate would prove a more important influence on shell thickness.

In so far as shell backing was concerned, it was believed that the cost of backing up could be a deterrent to the utilization of the process on many applications. It posed a high labour cost item, expensive shot- or sand-handling system; mould carriers, and material-handling equipment which it was believed would exceed the cost of an additional thickness of shell without the necessity of backing,

* Printed in the JOURNAL, July 2, 9 and 16, 1953.
† Printed on page 525 of this issue.

Shell-moulding Practice—Discussion

at least in this country. In addition, the advent of coated sands would make a heavier shell without back-up even more attractive economically.

MR. D. N. BUTTREY said on the question of shell thickness that the only way to get an economic idea was to take an average thickness. Shells varied in thickness in production and the only way to get a proper basis for comparison was to take the average weight over a long production run.

On the question of backing he entirely agreed with backing up a thinner shell to effect economy; this had a definite advantage but it was found in practice that a number of foundries which had worked on the process in Great Britain did not back with steel shot but sank their shells to varying depths into casting sand. That was not always complete backing, but rather using the sand to back up awkward parts.

Glued Dowels for Fixing

MR. P. G. PENTZ thought it should be borne in mind that the cost could be reduced to some extent where it was possible to use the double-investment technique with a coarser sand for the second investment. A coarser backing sand would provide the required strength with a considerable saving in cost, while the fine sand gave the usual good casting surface.

On the question of the thickness of the shell and the reason for it—the necessity to provide a certain resistance to distortion during casting—he commented on the point made by both Mr. Ames and by Mr. Buttrey, in connection with bonding the shell halves together, or securing them in some way. Mr. Ames had pointed out that they had found bolting most effective, but uneconomic. That was generally agreed. On the use of an adhesive as a bond it was pointed out that it had disadvantages. One had a certain definite thickness of adhesive which tended to reduce dimensional accuracy across the joint. These disadvantages of bolting or glueing could be overcome by using sand/adhesive dowels instead of metal bolts. Suitably-located bosses and corresponding recesses on the patternplate, and reproduced on the shells, enable the two half-moulds to be glued together without any glue on the main interface, *i.e.* on the joint line of the mould. The adhesive was applied to the projecting bosses only; and if there were enough of them the half-moulds were held together as firmly as by bolting, and with as little distortion.

Finally, on the question of " peel-back," referred to in the Paper by Mr. Buttrey, he agreed that this tendency for the soft, partly-formed shell to drop off the pattern immediately after investment was a function, in part, of the resin used: if the resin tended to flow too much it might produce peel-back. Did Mr. Buttrey agree, however, that peel-back was not only a question of resin but also was connected with two other factors, *viz.* pattern temperature and shell thickness ? As to the first, it had been found that the higher the temperature the less the tendency there was to peel-back for any given resin and shell thickness. On the question of shell thickness experience showed that for any given resin and pattern temperature there was a certain maximum shell thickness which could be built without getting peel-back.

MR BUTTREY agreed that the temperature of the pattern did influence the peel off but this was caused by several factors. The temperature of the pattern influenced shell thickness, although resin properties also had some effect on this factor. Different resins had their optimum temperature for working; certain of them were better worked at 180 deg. C. and others at 230 to 240 deg. C., but peel off was mostly concerned with the moulding properties of the resin itself.

Another factor which had not been mentioned was the sand. Certain sands allowed more complete packing and reduced peel off, but their effect was not very great.

On the question of the use of adhesives for cementing locating pins into holes opposing shells, this was a possible solution, but there was one point to consider. Locating pins and holes had to be, in general, a close fit, and if one shell had been lifted off the pattern and the other shell had been standing for perhaps two or more minutes, considerable temperature differences might exist between the two halves. In such a case differential contraction of the two halves could make matching difficult.

As regards double investment with sands containing different resin percentages, insufficient experience had been gained in practice to give an authoritative answer, but such double investment introduced an extra operation and it might be debatable whether the extra cost and labour of it would be justified.

MR. HALLETT said that in the interests of accuracy, it should be pointed out that Mr. Ames had not said in the Paper that bolting was uneconomic. What he had said was that it was the most expensive method, but he added that it was necessary in many operations. The fact that it was used extensively in the New York Shipyard meant that they did not regard it as uneconomic.

MR. AMES wrote commenting on the peel-back phenomena, that they had found that bolting lugs on the pattern tended to minimize this situation. In addition a 2 per cent. addition of iron oxide to the sand was very helpful.

Grain Size of Sand

MR. BROWN asked what was the optimum grain size of the sand, and the influence of clay in the mixture.

Dealing with these points, MR. BUTTREY said the particle size of the sand was the main factor in shell strength. Shell strength increased as the particle size of the sand increased. For example the strength of a shell made from carefully graded sand of 80 to 100 mesh mixed with a seven per cent. resin was roughly equivalent to that of a 9 per cent. resin mixture of 150 to 200 mesh sand. Therefore, since clay weakened the shell considerably it was fair to expect that using a coarser sand the effect of clay on lowering the strength would be off-set to some extent.

Mr Ames, here, wrote that in addition to the points raised by Mr. Buttrey, he had found that increased strengths were obtained with sand of rounded grains as opposed to angular sands of the same A.F.S. grain size. The effect of clay was to reduce the flexural and tensile strengths of the shell. As noted in the published Paper, grain distribution was also important in its effect on surface finish, a 5-or 6-screen sand being preferable to a 3-screen sand.

Experience in South Africa

MR. STEELE (South Africa) said his was a jobbing foundry and investment casting was found to be an economic process. Possibly, its cost was reduced by the fact that patterns were made by the investment casting process.

Mr. Steele then proceeded to describe a very simple turn-over dump box which his foundry had made from an oil drum in a crucible shank, and which, he said, gave very consistent and strong shells of even thickness. To take the temperature of their plates they timed the ignition of a match—the shorter the time the higher the temperature—and found this a very quick and easy and reasonably accurate way of estimating the temperature. They worked at a temperature of 250 deg. C. and the oven was maintained at 350 deg. C. In South Africa malleable cast iron, iron alloys, brass and bronze, aluminium and 18/8 stainless steels were being cast using sand of fineness 150 A.F.S., which had been found satisfactory. They were in the extremely fortunate position of having available a washed, graded silica sand supplied to specification.

MR. BUTTREY referred to the sand position in this country and said we were relatively short of suitable sands for the shell-moulding process at the present time. Only one or two sands could be considered as really satisfactory. He hoped that sand producers would bear that fact in mind and realise that graded sands were necessary. There did not appear at present to be reasonable supplies available of natural sands to support any large expansion of the shell process.

On the question of ejector pins, spring systems seemed to be satisfactory, but heat fatigue of springs had to be taken into account, and in the long run, cam systems might be more satisfactory. Ejector pins should be dispersed evenly over the whole plate and of the mushroom type for preference and fitting flush on the plate. This system reduced any sticking due to fine sand fouling the ejector mechanism.

A Matter of Perspective

MR. T. H. WEAVER said there were two points he would bring out at present. His first was in defence of the sand foundry. Many people thought the sand foundry was finished, but he hastened to assure them that if they would examine the matter from the beginning, on basic material costs, and follow both systems up to the finished product they would have food for thought. To give a concrete example. He had a particular casting weighing 28 lb., a fairly intricate cylinder which had to stand considerable pressure of petrol. The mould-material cost then was the original outlay for sand from which he could produce a ton of castings—about £4—8*s*.—and with that he could continue at any time making any consecutive number of castings for £1 a ton. The same job, if made in shell moulding, using P.F. resin and taking the Author's prices would cost £15 to £20 per ton of castings. In relation to die casting, from his experience shell moulding seemed to have no advantage, particularly in light-alloy work.

MR. HALLETT thought Mr. Weaver had brought out an important point. Founders must not run away with the idea that shell moulding was going to replace other methods in the foundry. Most emphatically it would not, and for the vast majority of work in which one wanted reasonable numbers of castings to a given standard the best methods of green-sand moulding, using good equipment would almost certainly win the day. That, of course, did not mean that the shell-moulding technique equally would not have an important place to fill, or where the customer needed particular accuracy, or particular surface finish, especially perhaps for some of the high-temperature resisting alloys such as austenitic steels. There, the shell-moulding process would almost certainly give a better job. The customer would have to pay more per casting for that, but the two processes were not mutually competitive in many instances. They should be regarded as complementary—each in its own field.

Shell Core-making

MR. B. LEVY said that one of the difficulties with the making of shell cores in similar style and material to the shell moulds was the levelling off and obtaining of a true top surface, where the sand/resin mixture was introduced into the corebox.

A method that had met with success was the employment of coreprint checks similar to those used for pistons, and additionally a baffle of asbestos on the top working face of the corebox, which would normally be the striking-off face. The purpose of the asbestos baffle was to prevent the build-up of the sand/resin mixture on the heated top surface of the corebox. Finally, the employment of a core-rubbing jig was desirable after the shell core had been baked.

Another point which Mr. Buttrey mentioned, but not specifically, was in regard to pattern design. Mr. Levy thought Mr. Buttrey was really referring to the runner/riser system rather than the pattern itself. There, he drew attention to one particular job where, for shell moulding, ingates had to be reduced to less than ⅛th of the normal size required for green-sand moulding practice. It was rather exacting to require a patternmaker to be conversant with the precise size of ingate that might be required, in view of the differences already noted between shell and green-sand moulds. One should bear in mind that there was bound to be a certain amount of trial and error for prototype castings.

Shell-moulding Practice—Discussion

On the subject of backing, he had seen some very heavy castings made satisfactorily by the shell process introduced into an ordinary moulding box and cast with green-sand backing.

MR. BUTTREY agreed with Mr. Levy about rubbing-down cores to size. Coremaking by the shell process, apart from certain specialized work, had not yet been developed so far as mould manufacture. Difficulties were the filling of coreboxes of intricate pattern, also resin segregation from the sand when blowing techniques were used.

On the question of pattern design, he agreed that on any particular casting, dimensions of runners and gates on the pattern were very much a question of trial and error at the present time. It was impossible on the basis of present knowledge to forecast with accuracy runner and gate dimensions for any given casting. It could be said in general that metal flow over shell-moulded surfaces was faster than over green-sand surfaces, and that as a result of the structure of the shell mould, chilling was greatly reduced; therefore, smaller runners (often choked) and closer gates were normal with shell moulds than those used with green-sand moulds for a particular casting.

Carbon Pick-up

A MEMBER, referring to carbon pick-up, asked if the lecturers could give any further information. When speaking of low-carbon steels, did they refer to low-carbon ordinary steels or low-carbon stainless steels?

Dealing with this point from memory, MR. BUTTREY said that steels containing approximately 0.24 per cent. carbon had shown increase on the surface to 0.28 per cent. or 0.30 per cent. carbon, but he could not recall what was the depth.

In this case it was a low-carbon steel, and reports had been received of very high pick-up in certain cases, but at the same time alloy steels had been cast satisfactorily and it was fair to say that at the present time insufficient data had been published to generalize on the question of carbon pick-up of steels, except to acknowledge that it was definitely known to occur in low-carbon steels, but not in some alloy steels.

MR. HALLETT, commenting on Mr. Buttrey's reply, said that his experience with steel indicated that austenitic steels of the heat-resisting type could certainly be cast (they had been in regular commercial production for some time), that was, 23 per cent. chromium, 12 per cent. nickel, and the 18/8 steels. Some of them had a carbon content of 0.15 per cent., in others it was between 0.2 and 0.25 per cent. In none of them had he experienced any appreciable pick-up of carbon on the surface. With a low-alloy nickel-chrome steel, his experience was not so extensive, but so far, he did not see any insuperable difficulties with shell-moulding steels of that type but he agreed there was room for further investigation and, as other speakers had said, certainly room for further data to be published.

Cores for Die-casting

MR. PORTER asked if Mr. Buttrey or Mr. Hallett had had any experience of dealing with the economics of shell cores compared with automatic plant producing ordinary cores. He was thinking of the application of sand cores in die-casting, when shell cores would seem to offer advantages.

MR. BUTTREY regretted he had no information and then explained it was very difficult to provide such data because, with many shell cores, the thickness varied, and even deciding upon the raw-material cost was difficult. It could only be worked out on very long runs, taking everything into account.

Replying to Mr. Porter's question, MR. AMES reported that in one installation in the United States simple shell cores are being produced in a multiple corebox by the dumping technique, competitive with cores produced by blowers in the conventional manner. The shell cores are employed in green-sand moulds. He believed that, if adequate venting could be obtained, shell cores could be used in the die-casting field.

MR. STEELE, on the question of supplying information, pointed out that in South Africa the position was complicated by Patent laws. Foundries which were working under licence were not permitted to divulge information and those not so working had great difficulty in getting replacement parts.

MR. WEAVER asked if Mr. Buttrey had any experience of the measurement of thermal expansion of the silica-sand grains during the shell-moulding process.

MR. BUTTREY replied in the negative: he knew that the shell did expand, but had not yet measured the actual expansion. That was one of the many things still to be done.

MR. WEAVER said information was available to the effect that hot-weakness of a shell due to a particular size and shape of the sand grains was of paramount importance; this, incidentally, again brought forward the question of basic material cost.

Comparative Costs

MR. GALE pointed out that there had been a lot of talk on the economics of shell moulding as compared with normal sand moulding. He thought members should be very careful in accepting too quickly at higher cost for shell moulding. For example, Mr. Dunlop had given some figures, but he thought he was correct in saying that those figures for varying thickness of shells referred only to the cost of the resin/sand mixture.

MR. DUNLOP interrupted to say: " Only the resin cost."

Continuing, MR. GALE said founders should bear in mind that when they talked of making a thinner shell to save resin cost, they had to back that shell and labour was still one of the most expensive commodities in the foundry. Extra labour to ram up the shell in the sand and to knock it out afteryards would be required.

If members went into the matter more carefully, they would find the cost was not as serious as they had been led to believe.

When considering cost, foundries should take the cost of the finished product and not the cost of the resin alone. If they could make a casting in the foundry by shell moulding it might cost a little more, but it might save expensive machining. That was where the real saving would come in.

Mr. Buttrey had rather shocked him by referring to differences across the joint of between 0.005 and 0.030 in.. When talking of 0.020 in. differences, nothing could be saved in machining. Here again, he thought there was unconscious exaggeration. He had produced experimental shell castings consistently to an accuracy of from 0.001 to 0.002 in. In that case a considerable saving accrued on machining operations.

MR. DUNLOP said he was not suggesting for a moment that the figures he quoted should rule out the use of shell moulding. All he was suggesting was that it should not be forgotten that the thinner shells might be cheaper if costs were examined. He had been wondering how long it would be before the Patent position was mentioned. It should not be forgotten that the original German Patents were now free to allied countries.

MR. BUTTREY pointed out, in regard to the matter of tolerance, that it was a speaker's job to be cautious.

Any statement of his on Patents would be purely a personal opinion, and quite frankly worth no more that that of anyone else in the conference. The only opinion worth having was that of a patent agent or some authority who fully understood the subject.

Casting Skin

MR. REYNOLDS pointed out that while he did not doubt the advantage of cutting out machining, one thing stuck in his mind—the average machinist said " For the Lord's sake don't let us be machining the skin. Give us enough metal and let us get under the skin." Was the skin going to be harder or softer in shell-moulded castings than in those conventionally made in green-sand ?

MR. HALLETT said the answer obviously depended on the metal being cast. Where there was a slower speed of solidification and a coarser grain size it might or might not be harder. The point about machining was not always one of saving money by reducing the amount of machining. Of importance was that for the average shell-moulded casting, one expected fewer of other difficulties such as sand inclusions, which in themselves controlled the amount of machining. Another point about the new process was that it often gave less scrap. It enabled founders to make jobs which could not be made otherwise. Whatever the individual cost of the casting, when taking the appropriate on-costs and after-costs into account, shell moulding might very well represent an economy.

MR. AMES wrote that, generally, the skin effect on shell-moulded castings was less than in conventional green-sand castings. This was due primarily to the insulating effect of the shell which resulted in a slower cooling rate. Shell-moulded castings should exhibit improved machinability.

MR. HUGHES said in view of the high cost of the resin he had been wondering if serious attention to the mixing proceedure might not result in a way being found to reduce the quantity of resin necessary. It had been said that any of the conventional types of mixing equipment in the foundry was suitable but he wondered if it might not be an advantage to evolve something entirely different. Only a small reduction in the amount of resin used would effect substantial saving.

The introduction of silica flour and iron oxide had been quoted as a means of improving the surface finish. He was wondering if the possibility of dusting the mould with one of those products prior to the introduction of metal would be as effective. Had it ever been tried ?

MR. BUTTREY agreed that if by some method the mixing could be improved and the resin content reduced, the process would be more economic. There was a difficulty, however, in trying to achieve this by better mixing. Taking the two main raw materials, the sand was already a graded sand. If any form of mixing was used which demanded a mill, and, in mixing, the sand was made finer, then the evidence to date suggested that the strength of the shell would drop rather than increase. The resin bonding material had already been reduced by a very efficient grinding technique including very fine screening to such a size that it appeared on the surface unlikely that any form of milling during mixing would give better dispersion in the sand than was already obtained by normal mixing. As to other ingredients, it might be thought that a wetting agent would help dispersal of the resin, but in fact no agent had been found which showed any real increase at all in the strength of the shell. Manufacturers of the resins, on their side, were doing their best to produce satisfactory resins as cheaply as possible. He stressed the word " satisfactory." On the question of dusting moulds, or surfacing with washes, work was being done, but no conclusive results were so far available.

Here, MR. AMES stated in writing that considerable development work was being carried on in the United States to develop coated sands, *i.e.* sand grains coated with a resin film. One high-production unit was currently being installed. It appeared that a reduction of at least one per cent., if not more. in resin content might be effected at no sacrifice of physical properties.

Non-ferrous Casting

MR. I. J. BIRCH said he had only one point to raise at that stage—an important one for non-ferrous founders, which had been dealt with to some extent in the American exchange paper. It referred to the thermal conductivity and insulating effect of the shell mould. Some quite good illustrations were given in the Papers, and he was aware that some aluminium test-bars had been cast in shell moulds and the effect of the lack of mould conductivity was such that too large a grain size was caused which seriously modified the final proper-

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ties of the alloy, both in tensile and elongation. That could be quite a stumbling block in the case of non-ferrous castings and he would like to know to what extent could it be surmounted. It seemed that those contemplating making aluminium or non-ferrous castings in shell moulds would definitely have to take some steps to increase the conductivity of their moulds.

Mr. Hallett said the last speaker had raised a valid point but, as it was rather late to reply at length, he would merely point out that the increased grain size which resulted from the lower heat loss was more than counter-balanced by the increased quality of the casting in other directions.

The President (Mr. Longden) then thanked the Authors of the Papers for having dealt with the subject in such an interesting way and formally recorded the appreciation of the members. The meeting was then closed.

WRITTEN COMMENT

Mr. T. H. Weaver wrote that, while the essence of the Papers was purely the achievements of American foundrymen, British foundrymen could claim some stable development of the process, but in this country founders still felt doubtful as to its maximum application, over and above traditional sand-foundry practice. It could be claimed that well above 400 British foundries have been, and still are, interested in the shell-moulding process, but the general present-day conclusions, he felt safe in saying, were that the process was limited, whatever be the basis of application—loose, mechanized or auto-flow production; size, weight and economics being the major considerations.

Some twelve months ago, quite a number of people in this country envisaged shell-moulding as being the end of all conventional sand foundries. Many of those who had heavy responsibility in capital outlay on mechanization and were about to develop and mechanize their foundries became very concerned about the value of the process, and it was to these that assurance was addressed, for shell-moulding was certainly not the end of sand-foundry production of castings.

Should there be the correct class and quantity of casting to make to warrant serious development in shell-moulding, then it was possible a founder may or may not develop upon the lines of founders in the United States. The process does remove many hazards encountered in the sand production foundry, but also brings others. The claims about skin finish and dimensional accuracy were true, but have their own special reasons and limitations.

Pertinent Comparison

Dealing further with comparative data, Mr. Weaver wrote:—"In examining certain fundamental principles of this process, it must not be assumed that the Papers are being denigrated in any way, but the following considerations are some facts of the shell-moulding process as laid down. The cost figures quoted are reasonably satisfactory in regard to the P.F. resin and silica-sand mixture—around £20 to £30 per ton, with a further consideration of £20-£40 per ton. This, of course, has a difference of 1d. per lb. and a variable of probably 3d. per lb. approximately. The writer's cost basis is of the order of 2s. 9d. per lb. for P.F. resins with washed silica sand, free from clay and carbides, such as Chelford or Redhill H. or G. using 5, 6 or 8 parts to 100 parts of sand. A personal opinion is that this mixture is too wide in the price range, and also too high. However, silica sand charges have increased much since shell moulding has come to its present prominence in this country, and this can only have a very bad effect upon the development and interest of the process, due to such economics being at fault. Thus, there is no doubt one can confirm that shell-moulding production is simple and the castings are accurate, but the structural stability of economics are not yet dependable or defined.

"However, one can from experience in this process, select the most simple benefit of economy, by the saving of heavy machining allowances, when casting high-priced non-ferrous materials and it is at this juncture that the process does show a definite material and çapital outlay economy. Ferrous materials, *e.g.*, grey iron, show no saving of any importance, or can saving be claimed by reduction of machining allowance. It is personal experience that one can machine off $\frac{1}{8}$ to $\frac{3}{16}$ in. at less cost than $\frac{1}{32}$ in. Nevertheless, if the design of the casting lends itself to a very simple lay-out for surface grinding, and machining can be entirely eliminated, retaining relative accuracy and soundness, then something has been achieved by the process. However, in a general run of work there is no guarantee of continuous large production quantities to justify the high costs of patterns and equipment. One may suggest an economy by eliminating or reducing the amount of feeding risers by this process, as against the size and weight of the risers associated with sand casting production. It has been noted that the specification of a grey iron has been quoted, and to what end this composition can substantiate any claims it is difficult to say. Castings produced in sand with a similar composition can be satisfactorily produced and machined. Of course, it is possible to query the fluidity and solidification rates in relation to the low total-carbon content, as a point of interest.

"For light-alloy castings, the writer has no doubt that the pressure-, or gravity-die casting production still leads for finish, accuracy and economy. Die-casting has a number of valuable features which are absent from shell-moulding.

Patterns and Storage Equipment

"It is agreed that patterns and equipment for shell-moulding are of major engineering importance and very costly, unless continuous large production is required at regular intervals; in any case metal patterns and equipment must be of first class quality. Surface finish is of greater importance on shell-moulding equipment than even a first-class pattern for sand-moulding production, for shells and castings produced can only be as accurate as the pattern, coreboxes and associated equipment. Considerable attention is also necessary to design, and expansion and contraction rates, while the equipment is in operation must have the fullest consideration. Close grey iron equipment of low carbon, phosphorus and silicon is preferred; generous tapers and radius are also essential.

"One must agree that the possibility of storing shells does show an advantage, but again at what economic level? Green-sand moulds cannot be stored for 12 months, which is the claim for shell-moulds; however, a well-planned mechanized sand foundry can deal satisfactorily with all urgent requirements. One might ask the question "what has been done previously when castings, even large production lots were required, of an urgent nature?" British mechanized foundry production today, in sand foundries, has adequate capabilities and efficient resources to meet most demands.

Details to be Considered

"Whatever alternatives be set out, the best methods of heating the pattern equipment and curing the shells from an economic outlook must be established. It is important that continuous production will give the maximum economy. Sand quality and grain size can only be determined economically in relation to the finish and accuracy required. The thermal expansion of the grains of silica sand is of much importance to the relative strength of accurate shells, particularly for high-temperature pouring, *i.e.*, at 1,500 to 2,000 deg. C.

"Wetting and separating agents that have been found most satisfactory for lubrication of the pattern equipment by the writer are Z.11502; silicon oils Z.11501 and P.F. resins R.17437, the quality of pattern finish being of further advantage to the stripping agent. Waxes and many other organic greases have not been found satisfactory, some due to build-up on the pattern and coreboxes to such an extent that production became difficult. Even after much cleaning the tendency is for retention of this collected residue in the corners of the pattern equipment and the grain or structure of the materials from which the pattern is made.

Cost Data

"Any comparison of basic material costs, namely of resin shell-moulding, *v.* sand-casting production, must be very carefully examined. The following apply to a casting of ½ to ⅝ in. section, weighing 28 lb.:—

Sand-foundry production.—Capital outlay to commence production in a natural sand would be £4 8s. 0d. for the first ton of castings. Each additional ton of castings with the sand material adjustment would be a maximum of £1, the amount of rammed sand used per casting being 1 cwt.

Shell-moulding production.—P.F. resin and silica-sand mixture are the basic materials for shell-moulding. The cost for production of each ton of castings is £10, £15 or £20. The shell mixture weighed 12 lb. for a shell of ⅛ to $\frac{3}{16}$ in. section by 16 by 16 in. These costs are "actual," *i.e.*, basic natural sand in relation to the sand/resin mixture. Any labour or equipment charges or anything beyond the basic materials must be considered as extra, and viewed in regard to the production conditions available.

"While British founders have accepted the achievements as outlined in the very-well-defined paper, by Mr. Ames, it is believed by the writer that the process has achieved its full momentum, as regards the purpose it may serve to the foundry and engineering industry. A number of people may still be considering whether to adopt the shell-moulding process, and an equal number has tried the process out and cannot justify the relative economics in comparison to the two foremost, *viz.*, sand-casting on a highly-productive mechanized plant, and die-casting of light alloys.

"Considerations upon experimental basis are under weigh in this country and the United States with a process which can associate itself with a wooden pattern, and should this meet all other necessary requirements as well as fundamental economics, shell-moulding will be ripe for further development and exploitation in the foundry industry."

Replying to Mr. Weaver's written comment, Mr. Ames wrote that he "would like to stress the point that the shell-moulding process was neither a cure-all nor would it replace a major portion of sand-casting production. However, in calculating the costs of the process one must examine the design of each casting critically and evaluate the cost of a finished-machined casting made by shell moulding as compared with a finished-machined casting made by conventional practice. In most cases, the greatest economies to be derived by the new process would be effected in the machine-shop and not in the foundry."

Results for Aluminium Alloys

Mr. I. J. Birch wrote that in the metallurgical section of Mr. Ames' Paper, dealing with the mechanical properties of aluminium alloy 43, it was stated that the overall properties were slightly superior for the shell-cast specimens. As no great use of that material is made in this country, he would like to ask if test results for materials similar to DTD424, or L51 (RR.50) alloys had shown the same slight superiority? Results obtained with these alloys using a standard D.T.D. test-bar shape, in shell-moulded form and cast under various conditions, have, in the writer's experience, suffered a deterioration in mechanical properties. The macro grain-size in most cases was comparable, and in some cases finer in the shell-moulded test-pieces.

On this question, Mr. Ames wrote that the physical properties of aluminium and tin-bronze alloys indicated no decrease in overall values, except for the yield point, in the shell castings as opposed to the green-sand castings. In so far as grain size was concerned, for tin bronze, the Author was not convinced that fine grain size (precipitated by a rapid cooling rate) was the optimum condition. He has had no experience with the alloys specifically mentioned.

Foundry Trades' Equipment and Supplies Association

At the annual general meeting of the Foundry Trades' Equipment and Supplies Association, held on October 22, the following report of the Council was presented to members:—

The number of members of the Association on December 31, 1953, was 65, ten new members having been admitted during the year. This number is an all-time record. The accounts for the year ended December 31, 1952, showed an excess of expenditure over income of £23 13s., leaving a balance of £33 8s. 3d. to be carried forward. The Council has met at intervals throughout the year and members have been kept informed of events in circulars.

The Handbook Committee has continued its work in connection with the printing of an up-to-date handbook and numerous copies of the current publication have been despatched to interested concerns in this country and oversea.

Members of the Association jointly contributed £188 14s. to the 1952 conference fund of the Institute of British Foundrymen. The Association has not participated in any exhibitions since the last annual general meeting, but members have exhibited individually in the Mechanical Handling Exhibition, held in 1952. The Association's representatives have attended meetings of the "Sub-committee on Conditions in Iron Foundries," during the year under review, and matters of interest to the industry have been considered. Close contact has been maintained with the Ministry of Supply, Engineering Advisory Council and summaries of proceedings have been reported to members.

Ventilation of Pedestal Grinders

Committee work has progressed under the chairmanship of Mr. G. E. Lunt in conjunction with the British Steel Castings Research Association regarding dust hazards on pedestal grinders, and, as a result, members who manufacture these machines are producing floor grinders incorporating modified dust-extracting systems for use in foundries. Proving tests have shown that the modifications in design enable the machines effectively to deal with a high percentage of the lighter dust without undue complication or interfering with the normal methods of operation.

Several meetings of the Ventilation Committee were held in an effort to investigate problems in regard to foundry heating and ventilation. It was found, however, that other organizations connected with the industry had made considerable progress on this subject, and it was felt, therefore, that to embark on such a programme would result in duplication of effort.

A committee is working with the British Steel Castings Research Association on the standardization of ladles.

The Association's representatives continued to serve on the Technical Committee of the British Standards Institution, and work was completed in regard to the standardization of moulding boxes. Moulding-machine manufacturers were approached to obtain their views on the standardization of their equipment, but as members were not generally in favour, the matter was not carried further. The question of the standardization of foundry ladles is now under consideration, and further conferences have been held with the Institution on the standardization of chilled shot and grit.

General

As a conclusion to their report, the Council wish to express the appreciation of members in regard to the efforts of those individuals who have given much of their valuable time for the benefit of the industry and the Association in particular. The opportunity must be taken to stress the need to maintain the fullest representation of the industry in the Association and of ensuring that it functions as a medium, not only in keeping members informed of topical subjects, but also for providing the necessary medium for the interchange of views amongst members.

The report is signed by Mr. F. Webster, the president and Peat, Marwick, Mitchell & Company, secretaries.

Officers Elected

At a Council meeting of the Association, following the annual general meeting, the following were reappointed as officers:—As *president*, Mr. Frank Webster (August's, Limited); as *vice-presidents*, Mr. Orton Foster (British Foundry Units, Limited) and Mr. W. Rawlinson (J. W. Jackman & Company, Limited). Mr. W. Aske (Wm. Aske & Company, Limited) and Mr. V. C. Faulkner (FOUNDRY TRADE JOURNAL) as *members of Council*. Mr. Gavin C. Paterson (Paterson Hughes Engineering Company, Limited) was also elected to the Council.

Hardness Testing of Metals

Various aspects and inherent problems associated with the accepted methods of hardness testing were discussed at a symposium in Sheffield recently, opened by the Master Cutler, Mr. R. Laurie Walsh. Concurrently, an exhibition of hardness-testing machines and equipment was on view in the City Hall, and this was opened by the Lord Mayor of Sheffield, Councillor Oliver S. Holmes, F.C.A.

Reproducibility of hardness tests was the subject of a Paper at the symposium by J. Woolman, of the Brown-Firth Research Laboratories, who confined his notes to a description of diamond and Brinell tests carried out on both block and strip test-pieces with a view to ascertaining the variations which were likely to arise in the hardness results finally recorded by the use of different indenting machines and reading devices, as well as an indication of the difference recorded by different operators. The author stated in his conclusions that an accuracy with ± 2 per cent. was attainable in diamond hardness tests on block samples with a good surface finish, from machines in a good state of maintenance. In Brinell tests, the difficulty of reading the diameter of the ball impression was likely to result in a lower accuracy of ± 4 per cent. Machines in which the indenter mechanism was actuated by spring loading appeared slightly more liable to error than those having lever-loaded indenters.

Surface finish was important for accurate diamond hardness measurements; the precision of measurements on strip with an as-rolled surface might be appreciably less than on well-prepared block samples, and on such surfaces the errors of reading the diamond impression were of the same order as those of reading the ball impressions. Appreciable local hardness variations occurred in most commercial steel samples; a number of impressions should be made to ensure that the average was representative of the material.

The value of hardness testing as inspection procedure was discussed by Dr. W. G. Shilling, of A.I.D. (Harefield), who attempted to sketch the more practical aspects of the subject and to give some idea of how inspectors make use of hardness testing. Confining himself mainly to Brinell and diamond-pyramid methods, with some mention of the Rockwell method, the author gave particular attention to means for speeding up reading or measuring the impression. For a long time there had existed, in his opinion, the need for an optical head to facilitate the measurement of impressions, and he described various apparatus designed to that end.

Personal

MR. E. J. FAIR, assistant lecturer in engineering at Glasgow University, is to take up an appointment as lecturer in engineering at Aberdeen University as from January 1 next.

MR. J. M. BOYD, who is chief switchgear engineer of the Electric Construction Company, Limited, has been elected president of the Wolverhampton and District Engineering Society.

DR. W. A. JENKINS, director of studies at the University College of North Staffordshire has resigned, on his appointment as vice-chancellor of the University of Dacca. He will be leaving to take up his new appointment in November.

MR. W. B. LAING has been appointed general manager of Bruce Peebles & Company, Limited, Edinburgh. He joined the company in 1920 as a pupil apprentice, and has held various posts in the company, since becoming a director in 1952.

MR. A. R. JENKINS, who is managing director of Robert Jenkins & Company, Limited, boilermakers, engineers, etc., of Rotherham, and president of the Institute of Welding, has been elected chairman of a newly formed productivity committee which covers the Rotherham district.

MR. EWEN H. SMITH, chairman and managing director of David Rowan & Company, Limited, engineers, Glasgow, has been elected chairman of the National Association of Marine Enginebuilders for the ensuing year . MR. P. L. JONES, M.C., director of Swan, Hunter & Wigham Richardson, Limited, Newcastle, has been elected vice-chairman.

MR. R. H. HALL has joined Foundry Services Limited to act as a technical representative in part of the Yorkshire area. Mr. Hall served his apprenticeship with Thomas Blackburn and Sons, Limited, of Preston, and after studying engineering and metallurgy at Manchester University became a metallurgist with the Northern Aluminium Company, Limited, of Rogerstone.

COL. F. A. NEILL, chairman and managing director of James Neill & Company (Sheffield), Limited, steel manufacturers, has been elected chairman of the East and West Ridings Region, Federation of British Industries. A past Master Cutler, Col. Neill is president of the British Hacksaw Makers' Association and of the Sheffield branch of the Incorporated Sales Managers' Association.

MR. G. D. ELLIOTT, manager of the ironmaking plant at the Scunthorpe works of the Appleby-Frodingham Steel Company (Branch of the United Steel Companies, Limited), has visited Cleveland, Ohio, U.S.A., to read a paper on " Smelting 100 per cent. With Sinter Burden " at a joint conference of the American Blast-furnace and Coke Ovens Association and the Chicago District Blastfurnace Association.

MR. W. SLOAN SMITH, deputy chairman and managing director of W. H. Arnott, Young & Company, Limited, iron and steel scrap and non-ferrous merchants, etc., of Glasgow, has been appointed deacon-convener of the Trades of Glasgow in succession to Mr. A. S. Dixon. Mr. Smith, who was collector of the Trades House between 1950 and 1952, is a former deacon of the Incorporation of Wrights.

BAILIE ANDREW M. SCOTT, who has been in charge of the engineering department of J. B. W. Smith, Limited, agricultural engineers, Cupar, since 1931, has been elected Provost of Cupar. He has been senior magistrate of the town for the past three years. Bailie Scott, who is 51, is a native of the town and was partner in the firm of Smith & Scott, general engineers and millwrights, before he took over the garage at Eden Place.

MR. T. J. L. SLINGSBY (Walter Slingsby & Company, Limited) and MR. T. P. Smith (Dean, Smith & Grace, Limited) represent engineering on the productivity committee which was formed at Keighley on October 20, at a private meeting convened by Mr. W. Wright, chairman of the Bradford and Keighley District Committee of the East and West Ridings Regional Board for Industry. Mr. W. H. Hearsum was elected chairman of the new committee.

Obituary

MR. W. J. BASSETT-LOWKE, founder and managing director of Bassett-Lowke, Limited, model engineers, of Northampton, died on October 21.

LT.-COL. O. H. C. BALFOUR, chairman of Peco, Limited, High Grade Steels, Limited, and Hall Green Non-ferrous Metals, Limited, and a director of other companies, has died at the age of 59.

MR. JAMES HENDERSON, who died recently at the age of 77, served for more than 60 years as a shipping clerk and traveller with Cruickshank & Company, Limited, ironfounders, etc., of Denny (Stirlingshire).

MR. CHARLES ALBERT GARDNER, director of the Sheffield Magnet Company and Gardshaw Foundry, Limited, Beighton, died on October 21, aged 82. He was also a director of John Clark & Company, manufacturing chemists, Sheffield.

SIR ARTHUR MIDDLETON, who had been chairman of the London County Council since April of this year, has died at the age of 61. He was on the boards of the London firms of Hobart Manufacturing Company, Limited, Frondor Engineering Company, (1948), Limited, Chandos Engineering Company, Limited, and Lotz, Abbott & Company, Limited, machinery merchants, etc. Sir Arthur was knighted in July.

I.P.E. Annual Dinner

The Lord Mayor of London was among the guests of the Institution of Production Engineers at its annual dinner held in the historic Guildhall recently. The president of the institution, Mr. Walter Puckey, presided. Sir Rowland Smith proposed the toast of "The Rt. Hon. the Lord Mayor, the Sheriffs, and the Corporation of London," to which the response was given by Sir Rupert de la Bère, M.P. Viscount Waverley responded for the guests, whose health was proposed by the president.

The dinner was made the occasion of the presentation of the institution awards. The institution medal for the best paper presented by a non-member during the year 1951-52 went to Dr. J. D. Jevons, for his contribution, " How the Production Engineer Can be Helped by the Metallurgist." The institution medal for the best paper by a member during the year 1951-52 was presented to Mr. A. Cameron, for his paper, "Increased Productivity by Workshop Practice." The Hutchinson Memorial award for the best paper by a graduate went to Mr. J. E. Poulter, for his paper entitled, "Industrial Application of Porous Ceramics," while the institution prize for the best performance in the Higher National Certificate in Production Engineering for the year 1951-52 was presented to Mr. W. E. Simpson.

News in Brief

THE ENGINEERING, MARINE AND WELDING EXHIBITION will be next held in 1955, from September 1 to 15.

A REVIEW of commercial conditions in Syria was published by Her Majesty's Stationery Office on October 20, price 1s. (post free 1s. 1½d.).

MORE THAN 60 PRIZES to apprentices of F. H. Lloyd & Company, Limited, Wednesbury, were presented by Mr. R. Wilson, works manager.

THE EARL OF DUDLEY has retired from the Board of British Iron and Steel Corporation, of which he had been chairman since its inception in 1935.

AN APPRECIATION COURSE on work study for personnel officers is to be held from November 27-29, at the College of Aeronautics, Cranfield, Bletchley, Bucks.

BROOKES & ADAMS, LIMITED, of Barr Street, Hockley, Birmingham, commemorated the firm's centenary with an assembly of directors and employees on October 22.

MANY TONS of scrap aeroplane parts in a yard of the Wolverhampton Metal Company, Limited, Wednesfield, caused a fire on October 21, when sparks ignited wooden propellers and cellulose on the metal.

IN CONNECTION with "Eye Safety Week," the Safety Goggles Division of J. & R. Fleming, Limited, of 146, Clerkenwell Road, London, E.C.1, have issued a poster for exhibition in works, carrying the slogan "Don't lose sight of Eye safety."

THE NETHERLANDS iron foundry industry has formed an export group—the Netherlands Iron Founders' Export Group or N.I.F.E.G. The director is Ir. A. Baron Krayenhoff, who is well known in international foundry circles.

B. LEVY & COMPANY (PATTERNS), LIMITED, have recently completed four large cast-iron coreboxes, of net weight 19 cwt. each, for export to Pakistan. The whole job has been completed some four or five months ahead of schedule.

GAINING 190 out of a possible 200 points, Foden's Motor Works Band won the *Daily Herald* national brass-band championship of Great Britain before a crowd of 10,000 enthusiasts at the Empress Hall, Earls Court, on October 17.

FOLLOWING the recent purchase of Round Oak Steel Works by Tube Investments, Limited, Sir Charles Bruce-Gardner has been appointed chairman. Viscount Ednam, Lord Dudley's heir, will maintain the family link with Round Oak Steel Works, as he is a director.

As from October 20, the Ministry of Materials has reduced its selling price (per ton) for tungsten ores of standard 65 per cent. grade and ordinary quality as follow:—Wolframite, from 310s. to 280s.; scheelite, from 300s. to 270s., delivered consumer's works.

CONSENT of the Capital Issues Committee has been obtained for the offer of Charles Clifford & Son, Limited, manufacturers of non-ferrous metals, etc., of Birmingham, to acquire the whole of the issued capital of the Hall Street Metal Rolling Company, Limited, Birmingham.

WICKMAN, LIMITED, COVENTRY, have been appointed sole selling agents for Edouard Dubied Et Cie, Neuchatel, Switzerland, the well-known Swiss machine-tool manufacturers, covering rapid copying lathes, high production lathes and universal tool and cutter grinding machines.

EMPLOYEES at the Coventry factory of Jaguar Cars, Limited, have gone on to a four-day week for an indefinite period because of a shortage of bodies, the result of the overtime ban at the Oxford factory of Pressed Steel, Limited. Short-time working was agreed to avoid large-scale dismissals.

HILLS (WEST BROMWICH), LIMITED, have secured a contract valued at 300,000 dollars for a prefabricated steel two-storey school to be built in Toronto. Representatives of the firm are going by air to supervise the erection. The firm has built over 300 schools by the Hills pre-weld system of construction.

A WEST MIDLANDS branch of the Institute of Marine Engineers has been formed with headquarters in Birmingham. The first meeting of the branch was held on October 22 when Mr. A. G. Arnold, of the "Blue Funnel" Line, spoke on "Burning of Boiler Oil in Two- and Four-stroke-cycle Diesel Engines and the Development of Fuel-injection Equipment."

DURING HIS INDUSTRIAL TOUR of the North Western Region, Mr. Duncan Sandys, M.P., Minister of Supply, visited the Prescot works of British Insulated Callender's Cables, Limited, on October 22. He was received by Mr. H. J. Stone, director and deputy chief executive, Mr. F. Waine, director, Mr. E. Bowyer, manager (production), and Mr. L. R. B. Spence, Prescot works manager.

"TRY to keep craftsmanship in being if you can" was the advice of Sir Henry Hinchcliffe, former president of the Association of British Chambers of Commerce when he spoke at the annual dinner of the Birmingham Junior Chamber of Commerce. Through craftsmanship, he said, there would still be a rôle for this country when the world was saturated with standard wares.

AT THE INVITATION of Rowe Bros. & Company, Limited, builders' merchants, audiences composed of aldermen, councillors, estate agents, architects, property owners, solicitors, surveyors, builders and plumbers saw "The Stockton Test," the film dealing with an experiment in housing rehabilitation, at the company's showrooms in Berkley Street, Birmingham, on October 20 and 21.

FROM the Exeter foundry and the engineering firm of Garton & King, Limited, have just been despatched four out-size gear rings for a cement mill in Canada. Each of the rings weighed about three tons, was 9-ft. dia., 1 ft. 2 in. wide, and carried 96 teeth. They were cast in a special steel-mix iron, so as to withstand the abrasive conditions in which they are to work. The rings, destined for British Columbia, began a 9,000-mile journey which will include passage through the Panama Canal.

BRITISH TRANSPORT COMMISSION has placed an order for three Diesel locomotives with the North British Locomotive Company, Limited, Glasgow. Negotiations are also under way between Scottish Regional officials and the company for the building of several more engines. The engines are part of the railways' programme for this year. The Government allotted £11,000,000 for new Diesel engines, and it is planned to have 573 built during the five years 1953-57.

THE FACTORY of the Emco Brass Manufacturing Company moved from Croydon to its new 14,000 sq. ft. premises at Westwood, Margate, during the weekend October 24-25. Some stock had already been moved, but the weekend task included the transporting of about 70 tons of machinery, factory gear and office equipment. The Emco Company is a subsidiary of the

(*Continued on p.* 552)

F.&M. FERRO-SILICON BRIQUETTES


F. & M. SILICON BRIQUETTE

It is well known that the hardness of ordinary cast iron depends to a large degree on the Silicon content of the metal. Silicon acts as a softening agent in cast iron by its action in reducing the amount of combined carbon, which is liberated in the form of free graphite. The presence of free graphite and a low combined carbon content contribute towards easy machineability.

For the past twelve years, since F. & M. Supplies Ltd. were the first to manufacture Ferro-Silicon Briquettes in this country, they have provided a practical, convenient and economical means of increasing the amount of Silicon in a cast iron. The necessary number of Briquettes is added to the charge in the Cupola and all the Silicon contained in the Briquettes passes into the molten metal with only a negligible loss *because the element is protected during its progress through the oxidising zone.*

An important function of **F. & M. Ferro-Silicon Briquettes** is in the production of dense iron castings with high tensile strength. The foundryman usually ensures sufficient "softness" in his castings by using a pig iron with 3 to 4 per cent. Silicon. Such pig irons are frequently coarse-grained with large graphite flakes and, when used in ordinary cupola mixtures of pig and scrap iron, are apt to give rise to castings containing large graphitic flakes. This coarse-grained structure, which is particularly developed in the thicker parts of the section, results in an iron of comparatively low tensile strength.

By using pig irons of medium Silicon content (2 to 2·5 per cent. Silicon) which possesses a denser structure owing to their smaller graphite flakes, and increasing the Silicon content of the metal by an appropriate addition of **F. & M. Ferro-Silicon Briquettes** to the cupola mixture, an iron with much smaller graphite flakes and, therefore, with a denser structure, is produced. At the same time, the metal is readily machineable, although it is denser and stronger, ***as the composition of the metal remains unaltered from that obtained by the use of higher Silicon coarse-grained pig irons.***

Technical advice for any special working conditions gladly given on request

DIRECT FROM MANUFACTURER TO YOUR FOUNDRY

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FERRO MANGANESE, SILICOMANGANESE AND FERRO CHROMIUM BRIQUETTES

News in Brief

(*Continued from p.* 550)

Empire Brass Manufacturing Company, and have a large export trade, their products going to 33 different countries.

AMERICAN INDUSTRIALISTS were so interested in quality control that many firms kept groups of "trouble shooters" ready to deal with any defects as they arise and who were qualified to rectify them, said Mr. A. Heward at a meeting arranged by the Institution of Engineering Inspection (Birmingham branch) early this month. Mr. Heward, chief inspector of W. & T. Avery, Limited, was a member of the British Productivity team which visited the United States to study inspection methods.

THE IRON AND STEEL BOARD, after consultation with the industry, have published and circulated to iron and steel producers concerned a notice requiring them to submit for the Board's consent (under Section 6 of the Iron and Steel Act, 1953), any proposals for modernization or development estimated to cost more than £100,000 and which fall within the scope of the Board's powers under that section. The Board will from time to time be reviewing this criterion in the light of experience.

THE NEW British Iron & Steel Research Association laboratories at Hoyle Street, Sheffield, which are to be opened by His Royal Highness the Duke of Edinburgh on November 19, will be open (by invitation) for inspection by anyone interested on the following day, November 20. The laboratories include those of the Cutlery Research Council. Application for invitations should be made in writing to Mr. Max Davies, B.I.S.R.A., 11, Park Lane, London, W.1, before November 10.

THE 220 EMPLOYEES of Dudley Foundry, Limited, are now enjoying the amenities of a social club they have founded themselves. Two years ago a committee was formed and a membership subscription of 3d. a week was fixed. Club funds rose slowly but two months ago the management closed an old pattern store and turned the top floor over to the club, together with a gift of £170. By working overtime, they tackled the conversion and now have a well-lit, tidy social club with a bar and billiards room.

THE SIXTH ANNUAL REPORT of the International Association for the Exchange of Students for Technical Experience shows that continuous progress is being made by the Universities of the world in the provision of vacation employment of students. The foundry industry is well catered for as hundreds of British and foreign firm co-operate. Moreover it is carried out at a minimum of administration costs. Details of the scheme can be obtained by writing to J. Newby, Imperial College, South Kensington, London, S.W.7.

THE CONCLUDING SESSION of the National Smoke Abatement Society's conference at Glasgow recently was devoted to the efficient and smokeless combustion of fuel oil. Mr. K. H. Sambrook, in a paper on the subject, said that fuel oil was generally accepted as being a smokeless fuel, but it was possible for it to produce considerable volumes of smoke. Without certain standards of maintenance and skilled operation it might be possible to avoid smoke, but only by reducing efficiency and thus consuming more oil than was really necessary.

WORK has begun at the Grimesthorpe, Sheffield, foundry of English Steel Corporation, Limited, on a series of heavy steel castings, valued at approximately £250,000, for the new works of the Steel Company of Wales and a steel works in Spain. The series consists of a considerable number of mill housings ordered by Davy & United Engineering Company, Limited, Sheffield. About 24 ft. long and 12 ft. wide, and weighing nearly 100 tons each, they will be cast in the new pits, which have a depth of 25 ft. and a total length of 190 ft.

ENGINEERING FIRMS in the Huddersfield district report that trade with dollar countries is becoming steadily more difficult, and the main reason given is rising prices at home. A large Norwegian order had recently been lost to a weighing-machine manufacturer in the Batley district who had been undercut by a German firm to the extent of £30 per machine. Another firm in the same district reported the loss of the whole of their former trade with Holland and Sweden, which two years ago was considerable, to German firms who had quoted lower prices.

THE OLDEST ORGANIZATION of its kind in the country, Birmingham Metallurgical Society celebrated its golden jubilee on October 21. Known originally as the Metallurgical Society of the Birmingham Municipal Technical School, it came into being in May, 1903, when a group of about 60 students at the school formed itself into a body to further its knowledge of metallurgical subjects. During its long history, many distinguished people have attended the society's meetings, and it is of interest to record that Mr. Neville Chamberlain presided at one of the lectures of the 1907-8 session.

THE TOTAL WORKING POPULATION in Great Britain increased by about 121,000 during August, according to figures issued by the Ministry of Labour. There was a slight decline of about 1,600 in the number of unemployed as at September 14. A marked increase in the total working population is normal during August, owing to the intake of school leavers into employment. At the end of the month the total working population amounted to 23,473,000. The number of persons registered as unemployed at September 14 was 291,970, representing 1.4 per cent. of the estimated total number of employees.

THE BRITISH STANDARDS INSTITUTION have just issued a revision of B.S. 1224 for electroplated coatings of nickel and chromium. The principal reason for this revision is that the original document did not fully meet the requirements of the motor-car industry and the document has been extended to cover coatings on materials other than steel and copper. The standard has been drawn up with a view to specifying the essential qualities of the coatings in question. It is realized that it is impossible at the present time to specify completely every factor affecting the performance of an electroplated coating. Copies of this standard may be obtained from the British Standards Institution, Sales Branch, 2, Park Street, W.1, price 2s. 6d.

SIR NORMAN KIPPING, director-general of the Federation of British Industries, speaking at the annual meeting of the F.B.I. North Midland Region at Nottingham on October 7, made the following announcement:—Her Majesty's Government and the Government of Iraq have given their approval to a proposal of the F.B.I. to organize a British Trade Fair in Baghdad in the autumn of 1954. Great and rapid developments are now taking place in Iraq as a result of the agreement between the Iraqi Government and the oil companies, which will increase the Iraqi budget by between £40 millions and £50 millions a year. Whilst the greater part of this money will go to the financing of large capital projects, such as flood escapes, dams, hydro-electric installations, bridges and roads, considerable sums will also go into consumer goods.

Raw Material Markets

Iron and Steel

There are no more blast furnaces in operation than there were a year ago, but the replacement of old stocks by new units of bigger capacity has made possible a steady rise in production, and supply and demand have been brought into a state of approximate equilibrium. of basic iron, which is going into direct consumption in of basic iron, which is going into direct consumption in the steel plants. Production of foundry iron is on a lower scale owing to the slackness in the light-castings trade. Some improvement has, however, been noted in the demand for No. 3 iron, and the inference is that the jobbing foundries are somewhat busier than they have been of late.

The ascending scale of ingot production has enabled British steelmakers to keep their own mills fully employed and also to provide bigger tonnages of steel semis to independent re-rollers. A steady flow of Welsh sheet bars into Scotland, for example, is still maintained, and imports from the Continent have been substantially reduced. There are, however, some cross-currents, such as the arrival of consignments of semi-finished steel from Australia, which suggests that there are still gaps to fill in the flow of first-class billets. The sheet mills are busier and are taking up substantial tonnages of bars and slabs, but the call for tube strip is slightly easier.

Trade in nearly all finished steel products is active. The only exception is that orders for small bars and light sections are insufficient to engage the full capacity of the light re-rolling mills. On the other hand, rollers of heavy sections, joists, rails, etc., have substantial bookings and the prospective relaxation of the restrictions on capital re-equipment opens up a favourable prospect for the year ahead. There seems to be no likelihood that the output of the plate mills will wholly overtake the demand for some time yet.

Non-ferrous Metals

Prices of non-ferrous metals last week moved in favour of holders. In London the close for lead at £94 for October showed a gain on the week of 35s. January was only 10s. higher, so that the backwardation widened to £4 10s. The scarcity of high-grade zinc continues and the London market put on 35s. for the current month and 30s. for the forward position. In the United States the price was unchanged at 10 cents. Tin fluctuated, but closed better, with gains of £5 in cash and £2 10s. in three months. The course of the copper market was most interesting, and the close last Friday at £240 for cash, which was unchanged on balance, and £221 5s. for sellers of three months (£2 15s. down) did not by any means represent the trend of values during the week. Due to the squeeze for early dates, cash copper was quoted early in the week at £247 10s., while three months stood at £228, but at this point the broker acting for the Government sold "contract" copper, which is a departure from the practice previously followed of dealing only on a prompt basis in fulfilment of consumer orders. This timely action had a salutary effect, and the cash position, which seemed to be getting out of hand, reacted sharply. The backwardation widened to nearly £19, and it may be that we shall see it wider still in the near future. Current quotations for brass and copper scrap continue to be very firm, but supplies of some types of brass are now more plentiful.

Statistics (in short tons) published by the Copper Institute for September show that output of crude copper in the United States was 79,480 tons, while production of refined improved by nearly 6,000 tons to 114,760 tons. Deliveries to domestic consumers were disappointing; at 104,885 tons they were fully 2,000 tons lower than in August. Stocks of refined copper in producers' hands at September 30 were 72,907 tons, compared with 78,825 tons a month earlier. Outside the U.S.A. there was a 27,000-ton increase in stocks of refined copper to 236,336 tons, this being a new high record. But production of refined copper, at 68,985 tons, was sharply down, comparing with 90,340 tons in August. Deliveries to fabricators in September were about 3,000 tons up at 47,000 tons.

Official metal prices were as follow:—

Copper, Standard—*Cash:* October 22, £232 10s. to £237 10s.; October 23, £235 to £240; October 26, £237 10s. to £240; October 27, £240 to £242 10s.; October 28, £238 to £240.

Three Months: October 22, £224 to £224 5s.; October 23, £220 10s. to £221; October 26, £222 10s. to £223; October 27, £225 to £226; October 28, £224 to £225.

Tin, Standard—*Cash:* October 22, £617 10s. to £620; October 23, £617 10s. to £620; October 26, £622 10s. to £624; October 27, £627 10s. to £630; October 28, £620 to £622 10s.

Three Months: October 22, £597 10s. to £599; October 23, £598 to £600; October 26, £606 to £607 10s.; October 27, £606 to £607; October 28, £604 to £605.

Zinc—*October:* October 22, £75 5s. to £75 15s.; October 23, £75 5s. to £75 10s.; October 26, £75 10s. to £75 15s.; October 27, £75 10s. to £76; October 28, £75 10s. to £75 15s.

January: October 22, £71 5s. to £71 15s.; October 23, £71 15s. to £72; October 26, £72 15s. to £73; October 27, £72 10s. to £73; October 28, £72 5s. to £72 10s.

Lead—*October:* October 22, £92 15s. to £93; October 23, £93 10s. to £93 15s.; October 26, £95 5s. to £95 10s.; October 27, £96 10s. to £96 15s.; October 28, £95 15s. to £96.

January: October 22, £88 15s. to £89; October 23, £89 to £89 10s.; October 26, £90 5s. to £90 10s.; October 27, £90 15s. to £91; October 28, £89 10s. to £90.

New Refractories

Examples of the advantages from co-operation between the manufacturer of refractories and the steelmaker were given in Glasgow on October 23 by Mr. A. McKendrick, a director of General Refractories, Limited, and managing director of the Glenboig Union Fireclay Company, Limited, to emphasize the main theme in his presidential address to the West of Scotland Iron and Steel Institute. Two new classes of refractories which had come very much to the forefront in recent years, he said, were dolomite bricks and carbon bricks and blocks. Considerable success had been achieved with dolomite bricks as the lining of basic-Bessemer converters at Stewarts and Lloyds' plant at Corby. Since its introduction in 1947 carbon brick and block had made fairly rapid strides in this country in blast-furnace linings and hearths, but as comparatively few furnaces had so far come off for inspection it was early to offer an opinion on the advantages of carbon. Although comparatively new in this country, it had been successfully used in Germany in the side walls and hearth for some years now, while 102 blast-furnaces were equipped with it in one form or other in the U.S.A. It was fairly confidently expected, however, that these would be a success in Britain.

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

(Delivered unless otherwise stated)

October 28, 1953

PIG-IRON

Foundry Iron.—No. 3 Iron, Class 2:—Middlesbrough, £13 18s. 0d.; Birmingham, £13 11s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £16 14s. 6d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £17 0s. 3d.

Scotch Iron.—No. 3 foundry, £16 11s. 0d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £18 3s. 0d.; South Zone, £18 5s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £19 3s. 0d.; South Zone, £19 5s. 6d.

Hematite.—Si up to 2½ per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. Coast and N.-W. Coast of England, £16 12s. 0d.; Scotland (Scotch iron), £16 18s. 6d.; Sheffield, £17 13s. 0d.; Birmingham, £17 19s. 6d.; Wales (Welsh iron), £16 18s. 6d.

Basic Pig-iron.—£14 6s. 6d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered).

Ferro-silicon (6-ton lots).—40/55 per cent., £53 10s. 0d., basis 45 per cent. Si, scale 21s. 6d. per unit; 70/84 per cent., £82 10s. 0d., basis 75 per cent. Si, scale 23s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 10s. 0d. to 11s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £165 0s. 0d. to £181 0s. 0d. per ton; 38/40 per cent., £229 0s. 0d. to £235 0s. 0d. per ton.

Ferro-tungsten.—80/85 per cent.,s. 18s. 6d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 21s. 6d. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent. C, £85 4s. 0d., basis 60 per cent. Cr, scale 28s. 3d. per unit; 6/8 per cent. C, £80 17s. 0d., basis 60 per cent. Cr, scale 26s. 9d. per unit; max. 2 per cent. C, 2s. 2d. per lb. Cr; max. 1 per cent. C, 2s. 2½d. per lb. Cr; max. 0.15 per cent. C, 2s. 3½d. per lb. Cr; max. 0.10 per cent. C, 2s. 3¾d. per lb. Cr; max. 0.06 per cent. C, 2s. 4d. per lb. Cr.

Cobalt.—98/99 per cent., 20s. 0d. per lb.

Metallic Chromium.—98/99 per cent., 6s. 3d. to 6s. 9d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £225 0s. 0d. to £232 0s. 0d. per ton; 96/98 per cent., £255 0s. 0d. to £262 0s. 0d. per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 40s. 0d. to 70s. 0d. per lb., Nb + Ta.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—Basic: Soft, u.t., £25 12s. 6d.; tested, 0.08 to 0.25 per cent. C (100-ton lots), £26 2s. 6d.; hard (0.42 to 0.60 per cent. C), £28 0s. 0d.; silico-manganese, £33 16s. 0d.; free-cutting, £28 16s. 6d. Siemens Martin Acid: Up to 0.25 per cent. C, £32 12s. 0d.; case-hardening, £33 0s. 0d.; silico-manganese, £34 17s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic soft up to 0.25 per cent. C, £29 16s. 0d.; basic, hard, over 0.41 up to 0.60 per cent. C, £30 16s. 0d.; acid, up to 0.25 per cent. C, £33 0s. 0d.

Sheet and Tinplate Bars.—£25 11s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast). £30 6s. 6d.; boiler plates (N.-E. Coast), £31 14s. 0d.; floor plates (N.-E. Coast), £31 15s. 6d.; heavy joists, sections, and bars (angle basis), N.-E. Coast, £28 9s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £32 4s. 6d.; flats, 5 in. wide and under, £32 4s. 6d.; hoop and strip, £32 19s. 6d.; black sheets, 17/20 g., £41 6s. 0d.; galvanized corrugated sheets, 24 g., £49 19s. 6d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £51 14s. 3d.; nickel-chrome, £73 3s. 6d.; nickel-chrome-molybdenum, £80 18s. 3d.

Tinplates.—57s. 9d. per basis box.

NON-FERROUS METALS

Copper.—Cash, £238 0s. 0d. to £240 0s. 0d.; three months, £224 0s. 0d. to £225 0s. 0d.; settlement, £240 0s. 0d.

Tin.—Cash, £620 0s. 0d. to £622 10s. 0d.; three months, £604 0s. 0d. to £605 0s. 0d.; settlement, £627 0s. 0d.

Zinc.—October, £75 10s. 0d. to £75 15s. 0d.; January, £72 5s. 0d. to £72 10s. 0d.

Refined Pig-lead.—October, £95 15s. 0d. to £96 0s. 0d.; January, £89 10s. 0d. to £90 0s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £104 5s. 0d.; rolled zinc (boiler plates), all English destinations, £102 0s. 0d.; zinc oxide (Red Seal), d/d buyers premises, £87 0s. 0d.

Other Metals.—Aluminium, ingots, £150 0s. 0d.; magnesium, ingots, 2s. 10½d. per lb.; antimony, English, 99 per cent., £225 0s. 0d.; quicksilver, ex warehouse, £61 15s. 0d.; nickel, £483 0s. 0d.

Brass.—Solid-drawn tubes, 22⅝d. per lb.; rods, drawn, 32⅜d.; sheets to 10 w.g., 243s. 0d. per cwt.; wire, 30¼d.; rolled metal, 239s. 9d. per cwt.

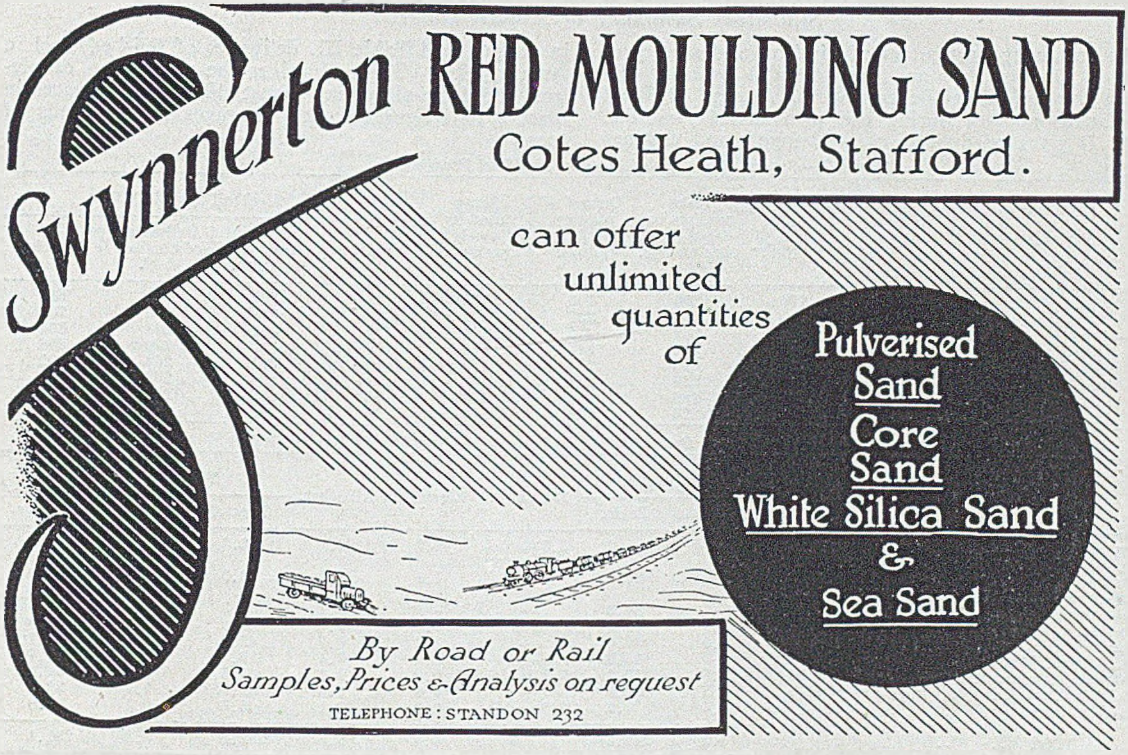
Copper Tubes, etc.—Solid-drawn tubes, 27¾d. per lb.; wire, 269s. 9d per cwt. basis; 20 s.w.g., 298s. 9d. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £185 0s. 0d. to £190 0s. 0d.; BS. 1400—LG3—1 (86/7/5/2), £190 0s. 0d. to £200 0s. 0d.; BS 1400—G1—1 (88/10/2), £252 0s. 0d. to £285 0s. 0d.; Admiralty GM (88/10/2), virgin quality, £252 0s. 0d. to £300 0s. 0d. per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £265 0s. 0d. to £295 0s. 0d.; L.P.Bl, £215 0s. 0d. to £240 0s. 0d. per ton.

Phosphor Bronze.—Strip, 354s. 0d. per cwt.; sheets to 10 w.g., 375s. 9d. per cwt.; wire, 44¼d. per lb.; rods, 38⅞d.; tubes, 37d.; chill cast bars: solids 41d., cored 42d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × .056, 3s. 0⅞d. per lb.; round wire, 10g., in coils (10 per cent.), 3s. 6d.; special quality turning rod, 10 per cent. ½ in. dia., in straight lengths, 3s. 5d. All prices are net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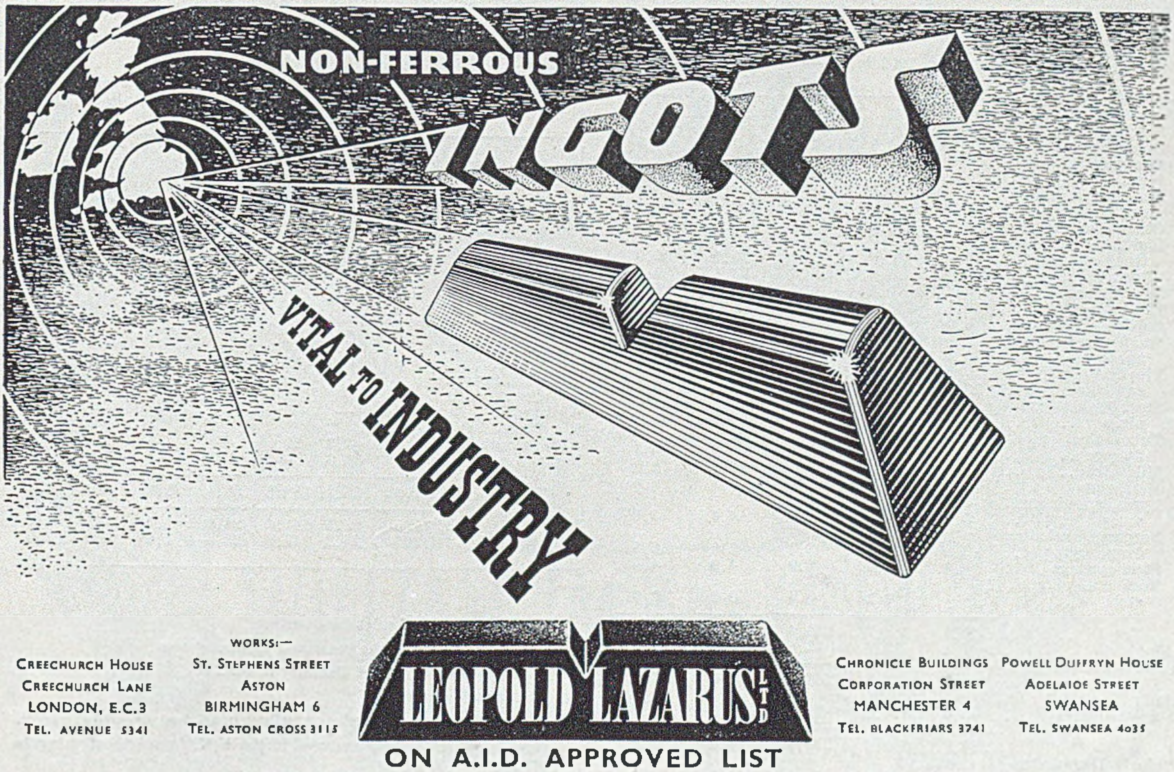
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Pig-iron and Steel Production

Statistical Summary of August Returns

The following particulars of pig-iron and steel produced in Great Britain are from statistics issued by the British Iron and Steel Federation for August. Table I summarizes activity during the previous six months. Table II gives production of steel ingots and castings in August and Table III, deliveries of finished steel in August, 1953. Table IV gives the production of pig-iron and ferro-alloys in August, 1953, and furnaces in blast. (All figures weekly averages in thousands of tons.)

TABLE I.—*General Summary of Pig-iron and Steel Production.*

Period.	Iron-ore output.	Imported ore consumed.	Coke receipts by blast-furnace owners.	Output of pig-iron and ferro-alloys.	Scrap used in steel-making.	Steel (all qualities).			
						Imports[1]	Output of ingots and castings.	Deliveries of finished steel.	Stocks.[2]
1951	284	170	206	186	175	8	301	244	585
1952[3]	306	190	228	202	171	29	310	252	739
1953—March[4]	334	197	237	216	194	23	351	261	804
April	319	189	242	213	189	20	349	270	868
May	319	198	243	215	190	19	351	263	902
June[4]	301	202	238	211	188	14	338	263	914
July	281	197	229	202	153	19	277	223	958
August	273	203	226	204	159	19	291	—	1,045

TABLE II.—*Weekly Average Production of Steel Ingots and Castings in August, 1953.*

District.	Open-hearth.		Bessemer.	Electric.	All other.	Total.		Total ingots and castings.
	Acid.	Basic.				Ingots.	Castings.	
Derby, Leics., Notts., Northants and Essex ..	—	5.0	7.3 (basic)	1.7	0.1	13.3	0.8	14.1
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire .. .. Yorkshire (excl. N.E. Coast and Sheffield) ..	1.0	21.3	—	1.1	0.5	23.0	0.9	23.9
Lincolnshire	—	36.3	—	—	0.1	36.3	0.1	36.4
North-East Coast	1.4	52.2	—	0.9	0.4	53.5	1.4	54.9
Scotland	3.9	37.9	—	1.6	0.7	42.3	1.8	44.1
Staffs., Shrops., Worcs. and Warwick	—	15.3	—	1.0	0.4	15.3	1.4	16.7
S. Wales and Monmouthshire	2.7	52.3	5.9 (basic)	0.9	0.1	61.3	0.6	61.9
Sheffield (incl. small quantity in Manchester) ..	5.5	20.8	—	6.9	0.4	31.9	1.7	33.6
North-West Coast	0.4	1.2	3.8 (acid)	0.3	0.1	5.7	0.1	5.8
Total	14.9	242.3	17.0	14.4	2.8	282.6	8.8	291.4
July, 1953	15.3	226.6	18.0	14.0	2.7	268.4	8.2	276.6
August, 1952	18.5	222.9	20.9	14.2	3.0	270.6	8.9	279.5

TABLE III.—*Weekly Average Deliveries of New Non-alloy and Alloy Finished Steel.*

Product.	1951.	1952.[3]	1952.	1953.	
			July.[4]	June.[4]	July.
Non-alloy steel;					
Ingots, blooms, Billets and slabs†	4.0	4.5	3.5	3.7	3.5
Heavy rails, sleepers, etc. ..	10.1	9.8	9.9	12.1	10.3
Plates ⅛ in. thick and over ..	41.0	41.4	35.2	49.6	42.6
Other heavy prod.	39.9	39.0	29.5	44.3	32.5
Light rolled sections and bars ..	46.7	46.0	40.1	50.6	39.9
Wire rods	15.9	15.9	11.6	13.8	9.6
Bright steel bars ..	6.5	6.5	5.7	6.4	6.1
Hot-rolled strip ..	19.5	18.8	16.4	18.0	15.3
Cold-rolled strip ..	6.0	6.1	5.4	4.8	4.0
Sheets, coated and uncoated ..	30.4	31.6	31.2	34.3	29.0
Tinplate, terneplate and blackplate ..	13.8	16.0	16.2	13.9	13.9
Steel tubes and pipes	20.3	20.1	17.4	20.0	18.8
Tube and pipe fittings	0.5	0.4	0.4	0.3	0.3
Mild wire	11.6	12.2	10.0	10.0	8.2
Hard wire ..	3.5	3.6	2.8	3.2	2.9
Tyres, wheels and axles	3.7	3.5	3.5	4.4	3.9
Forgings (excluding drop forgings) ..	2.3	2.8	2.3	3.0	2.5
Steel castings ..	3.8	4.2	3.9	4.0	4.0
Tool and magnet steel	[8]	0·3	0·4	0·2	0·3
Total	279.5	282.7	245.4	296.6	247.6
Alloy steel	11.4	13.7	12.8	12.4	12.2
Total deliveries from U.K. prod.[6] ..	290.9	296.4	258.2	309.0	259.8
Add; Imported finished steel ..	5.8	13.8	19.6	5.8	4.7
	296.7	310.2	277.8	314.8	264.5
Deduct; Intra-industry conversion[7] ..	55.0	60.2	51.6	53.9	43.5
Total net deliveries..	241.7	250.0	226.2	260.9	221.0

TABLE IV.—*Weekly Average Production of Pig-iron and Ferro-alloys during August, 1953.*

District.	Furnaces in blast.	Hematite.	Basic.	Foundry.	Forge.	Ferro-alloys.	Total.
Derby, Leics., Notts., Northants and Essex	26	—	19.9	20.1	1.2	—	41.2
Lancs. (excl. N.W. Coast), Denbigh, Flints. and Cheshire .. Yorkshire (incl. Sheffield, excl. N.E. Coast) ..	8	—	14.5	—	—	1.3	15.8
Lincolnshire ..	13	—	30.3	—	—	—	30.3
North-East Coast	24	4.4	42.2	—	—	1.4	48.0
Scotland	9	0.7	14.0	1.9	—	—	16.6
Staffs., Shrops., Worcs. and Warwick ..	9	—	8.0	1.2	—	—	9.2
S. Wales and Monmouthshire	8	3.3	21.0	—	—	—	25 2
North-West Coas	8	16.8	—	0.2	—	1.1	18.1
Total ..	105	25.2	150.8	23.4	1.2	3.8	204.4
July, 1953 ..	105	28.5	144.6	24.8	1.0	3.5	202.4
August, 1952 ..	105	26.8	141.9	28.4	1.2	3.6	201.9

[1] Weekly average of calendar month.
[2] Stocks at the end of the years and months shown.
[3] Average 53 weeks ended January 3, 1953.
[4] Five weeks all tables.
[5] Other than for conversion into any form of finished steel listed above.
[6] Includes finished steel produced in the U.K. from imported ingots and semi-finished steel.
[7] Material for conversion into other products also listed in this table
[8] Included with alloy steel.

Forthcoming Events

NOVEMBER 2

Institute of British Foundrymen

Sheffield branch:—"Core Assembly as a Production Aid to the Jobbing Foundry," by E. H. Beech and J. Hoyes, 7.30 p.m., in the Sheffield College of Commerce and Technology, Department of Engineering, Pond Street.

Beeston Boiler Foremen's Association

"Shell Moulding," by D. N. Buttrey, 7.30 p.m., in the Canteen, The Beeston Boiler Company, Limited, Mona Street, Beeston, Notts.

NOVEMBER 3

Slough section:—Open discussion with the Engineering Industry Association, 7.30 p.m., in the Lecture Theatre of High Duty Alloys, Limited.

Incorporated Plant Engineers

London branch:—"Functions of Materials Handling in Industry," by L. Landon Goodman, 7.30 p.m. (preceded by tea at 6.30), at the Royal Society of Arts, John Adam Street, Adelphi, Strand.

Institution of Production Engineers

Nottingham section:—"Work Measurement," by Professor T. U. Matthew, 7 p.m., in the Welbeck Hotel, Milton Street.

Institution of Works Managers

Sheffield branch:—"Incentives in Industry," introduced by S. G. Massey, 7.30 p.m., in the Grand Hotel. Joint meeting with the Institute of Personnel Management.

Sheffield Kindred Societies

"The W.1400 Walking Dragline," by P. Whitaker and Dr. J. S. Blair. Joint meeting of the Sheffield Metallurgical Association, Sheffield Society of Engineers and Metallurgists, and the Institute of Metals, 7 p.m., at B.I.S.R.A., Hoyle Street.

NOVEMBER 4

Incorporated Plant Engineers

Southampton branch:—"Employers' Liability," by Robert Hughes, 7.30 p.m., at the Polygon Hotel.

Institution of Production Engineers

Peterborough sub-section:—"Materials for Modern Production," by J. A. McIntyre, 7.30 p.m., at the Dujon Ballroom, Market Place.

NOVEMBER 5

Institute of Metals

Birmingham local section:—"Metals or Plastics," a discussion, 6.30 p.m., James Watt Memorial Institute, Great Charles Street.

East Midlands Metallurgical Society

"Training of Metallurgists," by Dr. A. D. Merriman, 7.30 p.m., in the Nottingham and District Technical College, Shakespeare Street.

Institution of Production Engineers

Glasgow section:—Open discussion night, 7.30 p.m., at the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent.

Liverpool graduate section:—"Time and Motion Study as Applied Chiefly to Manual Operations," by O. Blenkinsop, 7.30 p.m., at the Exchange Hotel.

NOVEMBER 6

Institution of Works Managers

Notts and Derby branch:—"Problems of My Job," open evening, 8 p.m., Welbeck Hotel, Nottingham.

NOVEMBER 7

Institute of British Foundrymen

Wales and Monmouth branch:—"Aluminium Pattern Equipment by the Pressure-cast Plaster Process," by D. H. Potts, 6 p.m., Engineers' Institute, Cardiff.

West Riding of Yorkshire branch:—"Practical Aspects of Shell Moulding," by C. Potter, 6.30 p.m., at the Technical College, Bradford.

Recent Wills

GARROOD, F. F., senior director of Elliot & Garrood, Limited, ironfounders, of Beccles (Suffolk)	£7,361
STIRK, RUFUS, formerly of John Stirk & Sons, Limited, machine-tool manufacturers and ironfounders, of Halifax	£15,285
ELLISON, W. T., late of W. T. Ellison & Company, Limited, brassfounders and engineers, of Salford (Lancs)	£2,206
WELLS, T. L., formerly a director of Jonas Wells, Limited, brass and malleable-iron founders, etc., of Keighley (Yorks)	£69,251

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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

TECHNICAL SALES EXECUTIVE post required with plant manufacturers or similar by Foundry Engineer. Comprehensive background of design, development, maintenance. Offers invited, requiring conscientious work with initiative and scope for advancement.—Box 3834, FOUNDRY TRADE JOURNAL.

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DRAUGHTSMAN required, preferably with experience of Gravity Dies, Pressure Dies or Plastic Moulds.—Apply JOHN DALE, LTD., London Colney, Herts.

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A TECHNICAL REPRESENTATIVE is required by Bagshawe & Co., Ltd., Dunstable Works, Dunstable, to handle sales of malleable iron castings. Some practical foundry experience is considered essential. The foundry concerned is of a light repetition character, and previous experience of sales of this type would be an advantage. Applications, which will be treated in confidence, should be from men about 35, and must state full details of experience and salary required.

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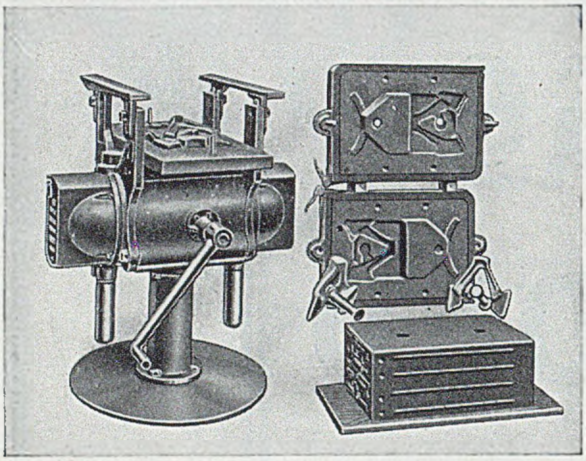

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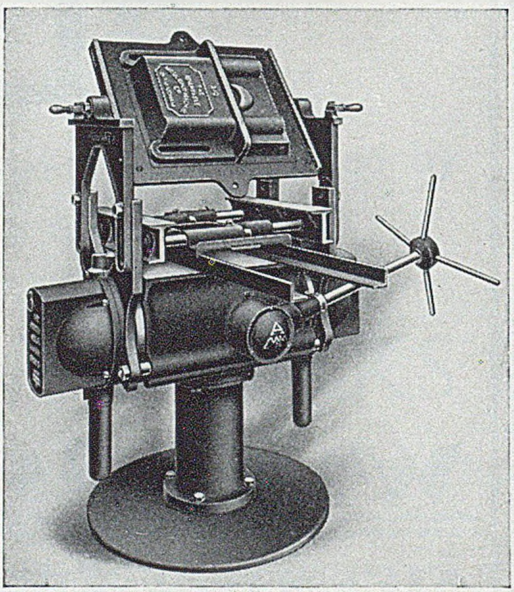

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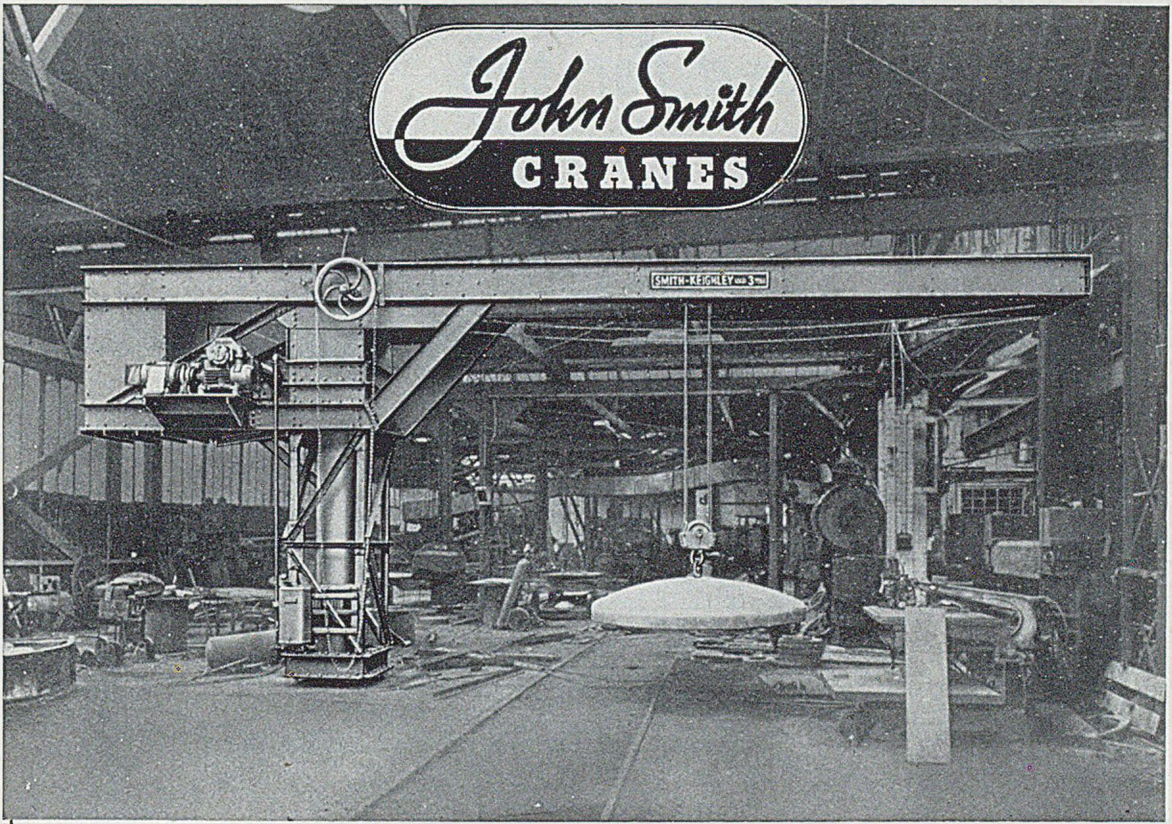

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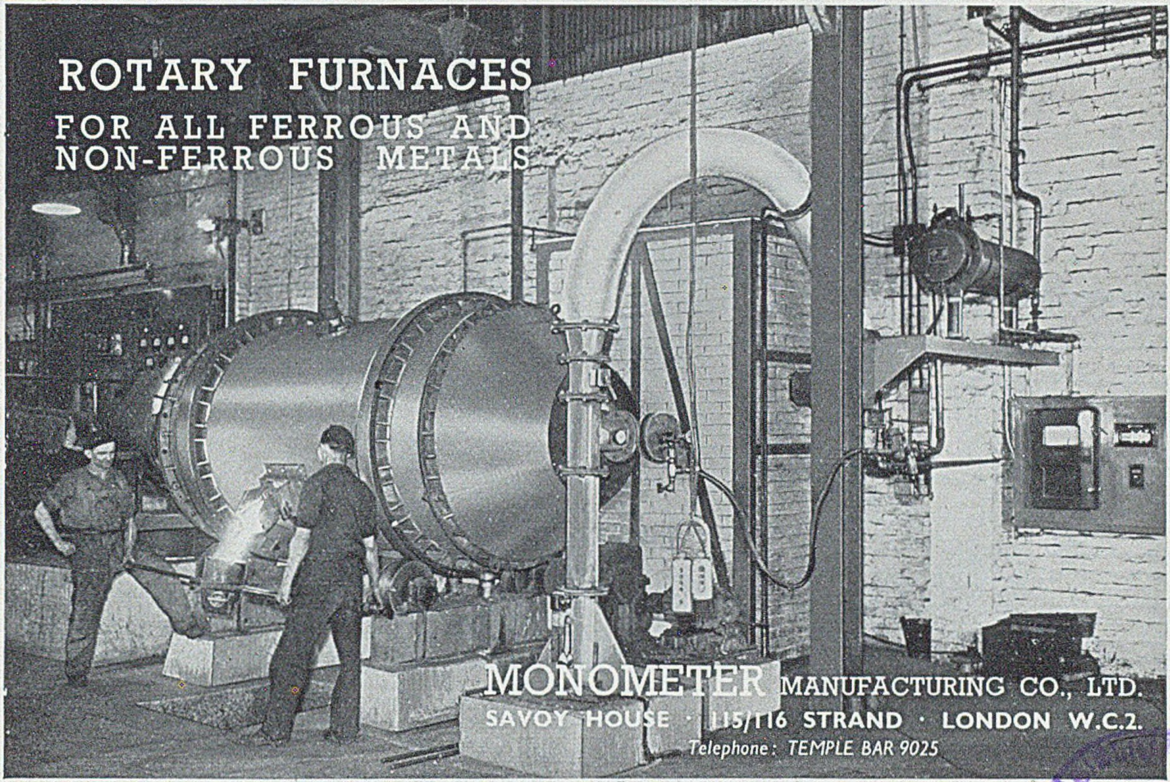
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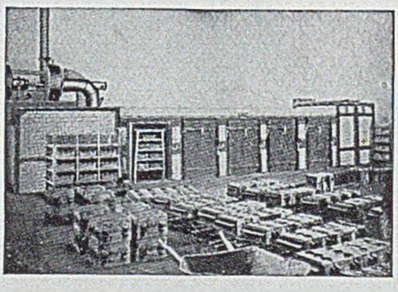

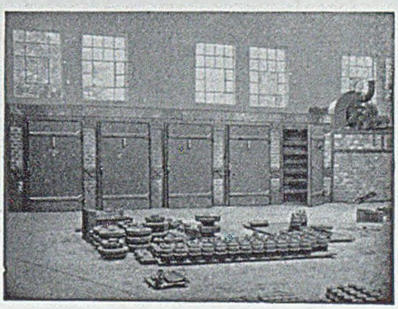

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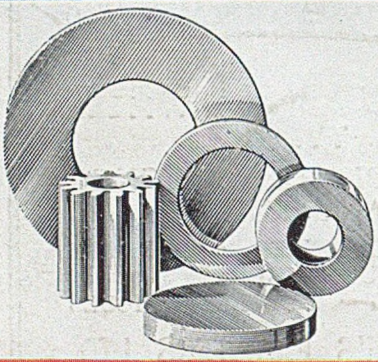

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