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JULY 16, 1953
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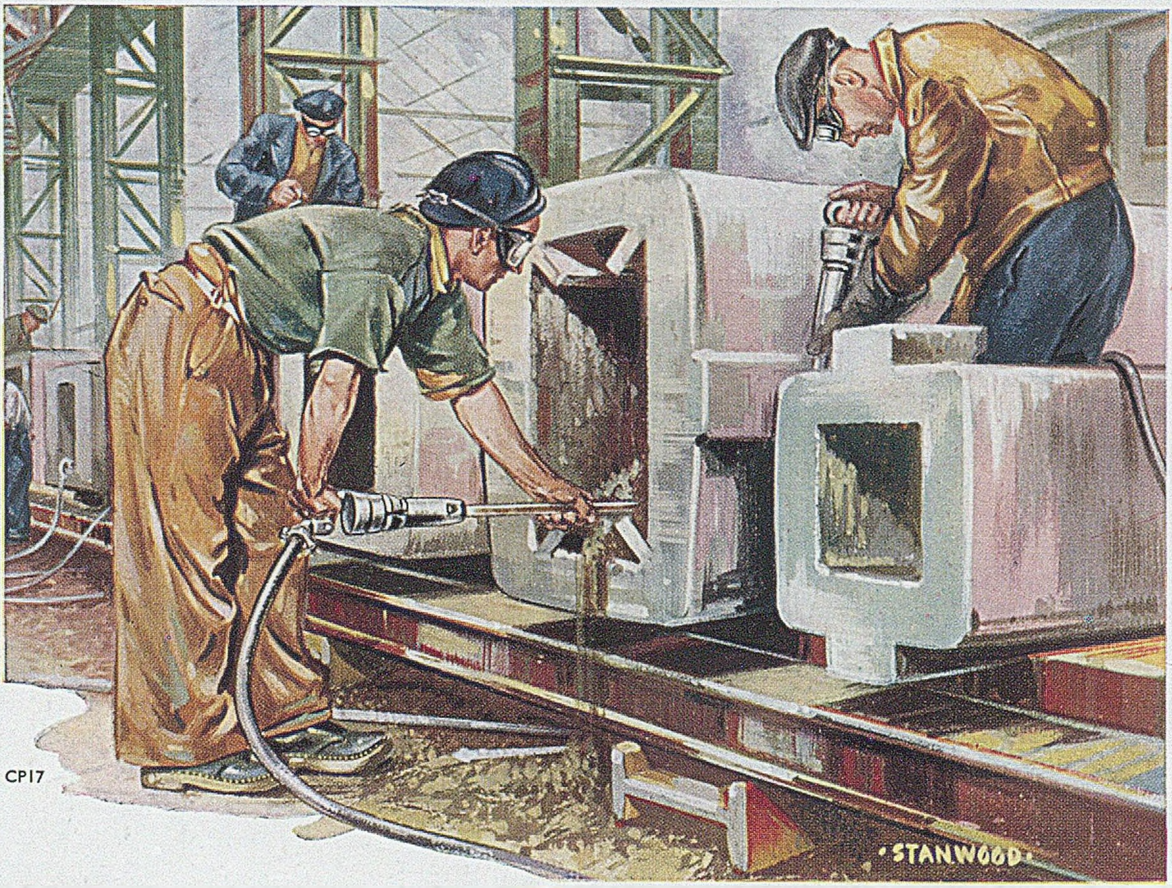
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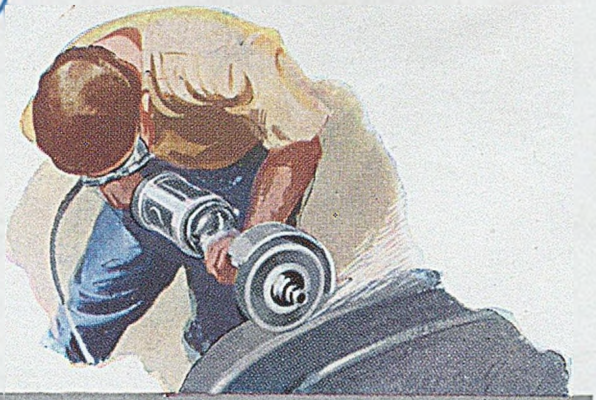
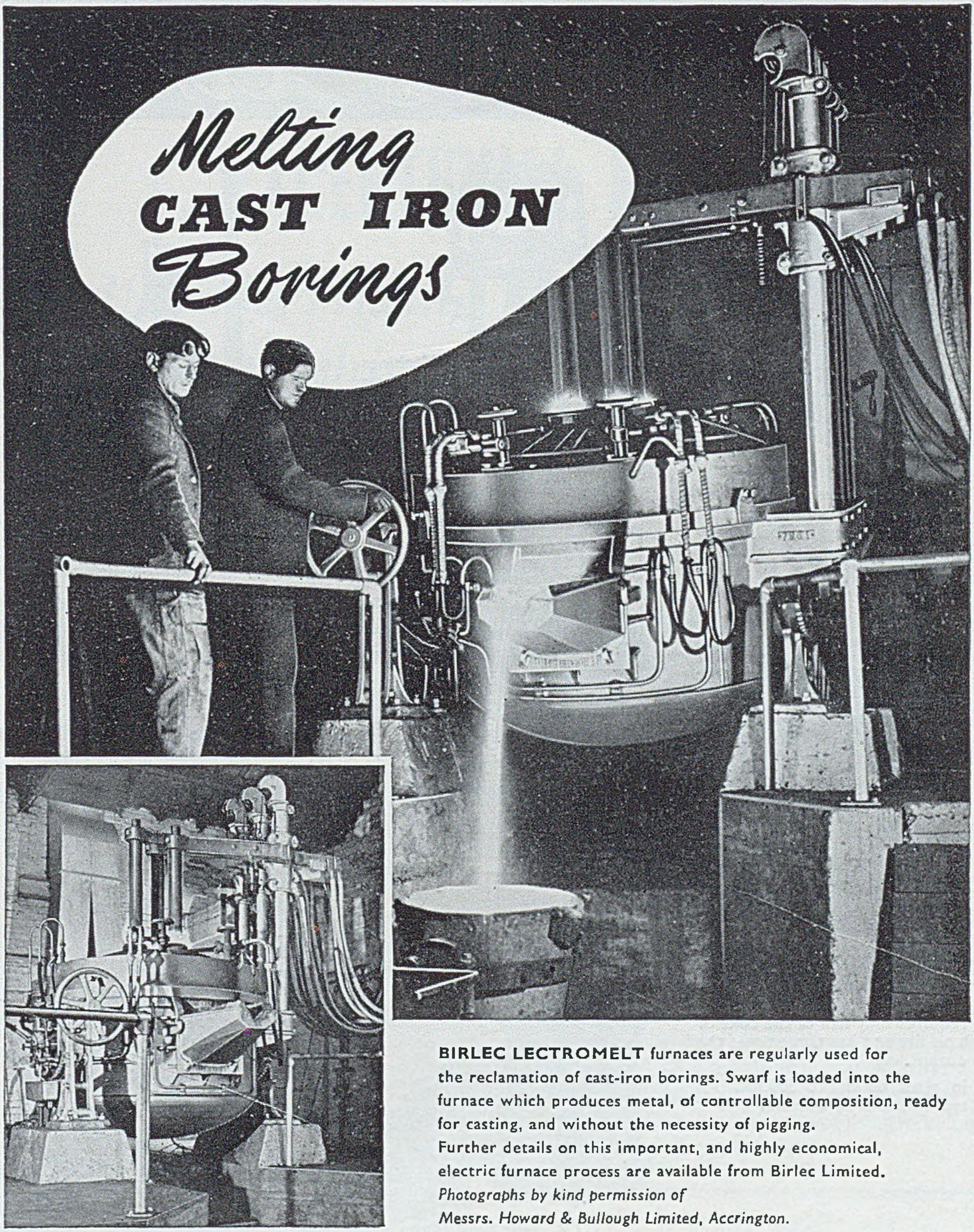
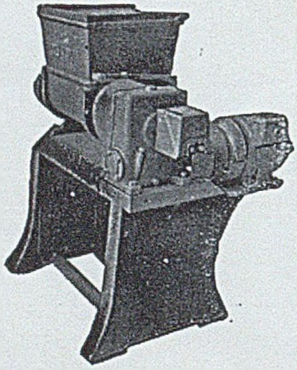


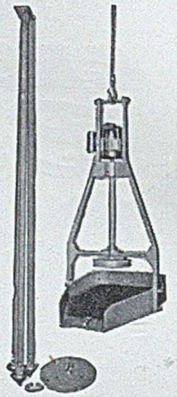

Melting
CAST IRON
Borings

"CUMMING" *lines*



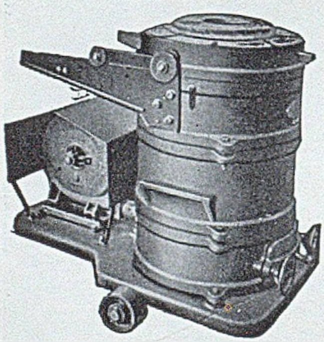
Sand Mixers have motor driven gears running in oil, replaceable blades, capacity 60 lbs. every 5 minutes. Floor space 4ft. × 3ft.

Hand Rammed Moulding Machines to turn-over and down-draw. Boxes up to 30in. × 18in. (standard 15in. × 15in.) can be handled.



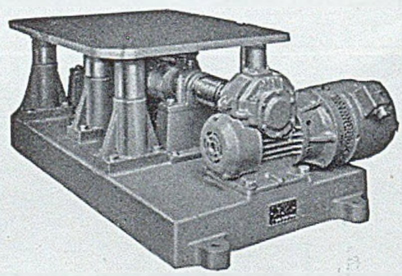
Electric Sand Riddle with automatic discharge. It is a very great labour saver. A 24in. round riddle can be supplied if preferred. Suitable for use with or without tripod.

WILLIAM CUMMING
& Co. Ld.
KELVINVALE MILLS
MARYHILL GLASGOW
AND AT
FALKIRK
CHESTERFIELD
DEEPFIELDS
MIDDLESBRO
Est. 1840



The Cumming Crucible Melting Furnace which is widely known as among the best of its type, requires only half of the coke of a pit fire and has three times the output.

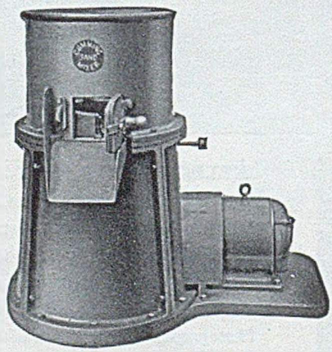
In sizes 60 lbs. to 500 lbs. All types have drop bottom.



Patent Jolt Moulding machine eliminates hand ramming.

Patterns are never damaged by jolt ramming, no compressors, air receivers, or air pipes needed. Wear and tear are very light.

Made in 5 sizes



C.I.V. Type Sand Mixer.
Cast iron body
is designed to handle about 1 cwt. sand.

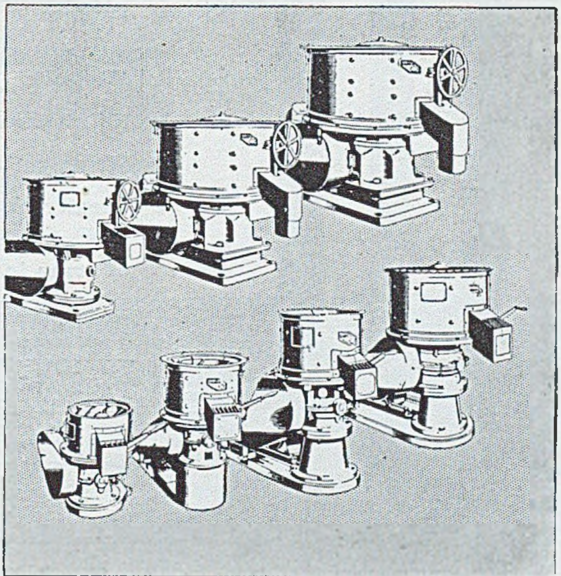
Discharge is through a hinged gate, and the machine completely clears itself in about 30 seconds. From starting the machine to completion of discharge of the green sand requires about 4½ minutes.

TWO FOUNDRY MACHINES OF EXCEPTIONAL MERIT

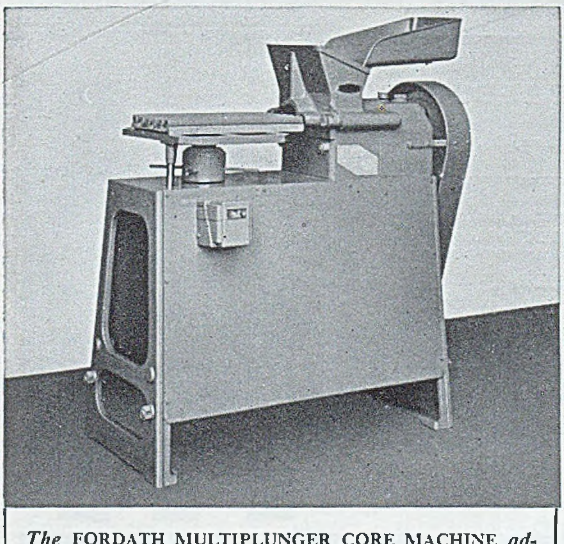
Sand/Binder Mixing without crushing

ACCURATE CORE EXTRUSION WITH ANY GRADE SANDS

The Fordath 'New Type' Mixer, in seven sizes with capacities from 20 lbs. to 1 ton, mixes foundry silica sands with core bonding compounds without crushing. It mixes and discharges in 2 to 3 minutes a well aerated homogeneous mix. Stiff compounds as low as 1% can be completely dispersed through the sand. Fordath Mixing Machines are hard at work, day after day, in foundries everywhere. It is therefore a simple matter to arrange to see one in operation.



FORDATH 'NEW TYPE' MIXING MACHINES *use the well known Fordath principle of rubbing and folding without crushing in each of the seven models in the range.*



The FORDATH MULTIPLUNGER CORE MACHINE *admirably exemplifies the success of equipment designed by foundrymen for foundrymen.*

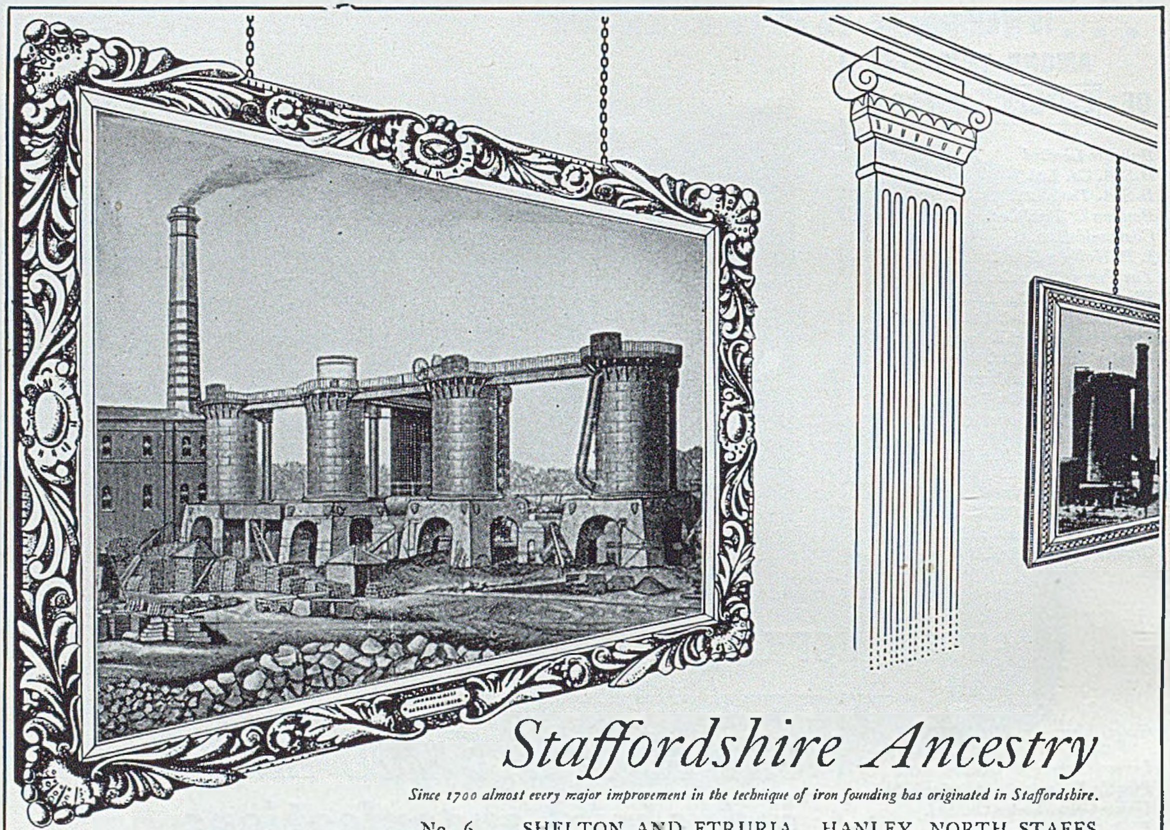
The Fordath Multiplunger Core Machine takes the extrusion of accurate cores a substantial step forward. The positive thrust of the core-mix through the multiple die by plunger action produces dimensionally accurate cores when sands of poor quality have to be utilised; even facing sand or plain red moulding sand can be extruded satisfactorily. The appeal of this machine to costing-conscious foundrymen was immediate from the day of its introduction, and there have been many repeat orders.

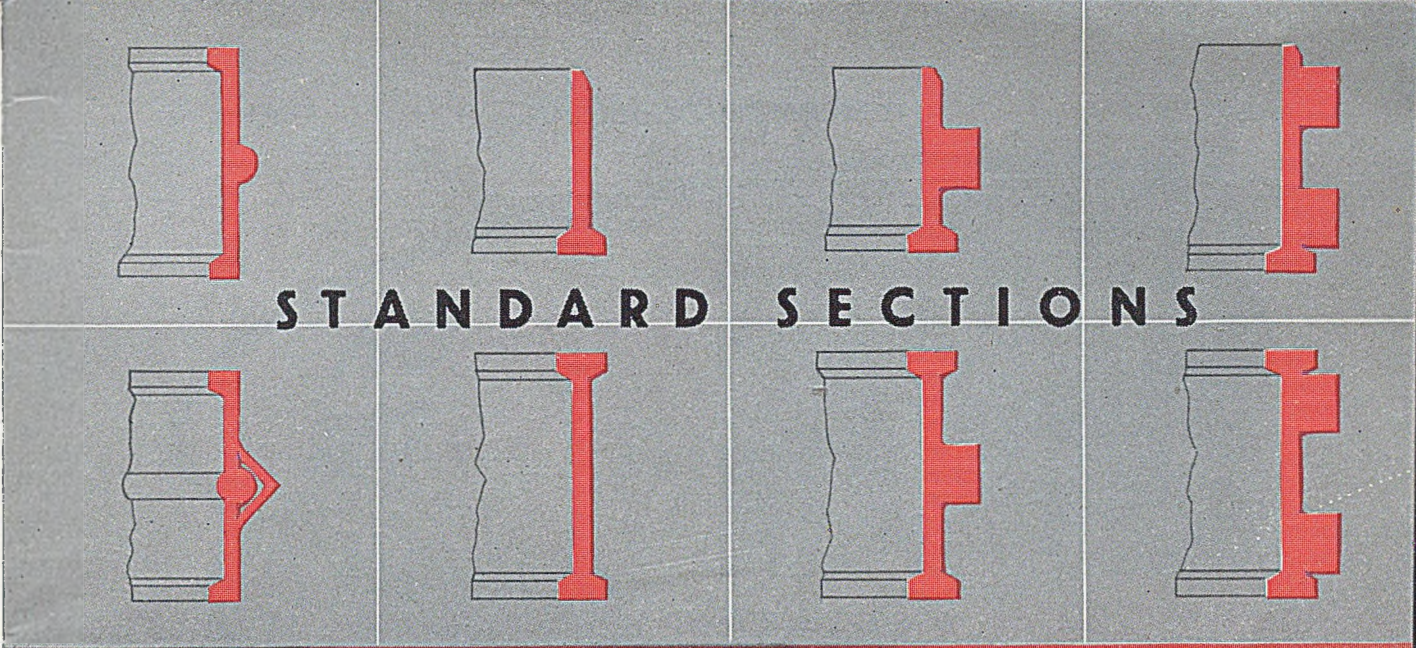
Arrange to see these machines at work

Full details from:

GLYSO CORE BINDERS

THE FORDATH ENGINEERING CO. LTD.
HAMBLET WORKS, WEST BROMWICH, STAFFS.
PHONE: West Bromwich 0549, 0540, 1692
GRAMS: Metallical, West Bromwich

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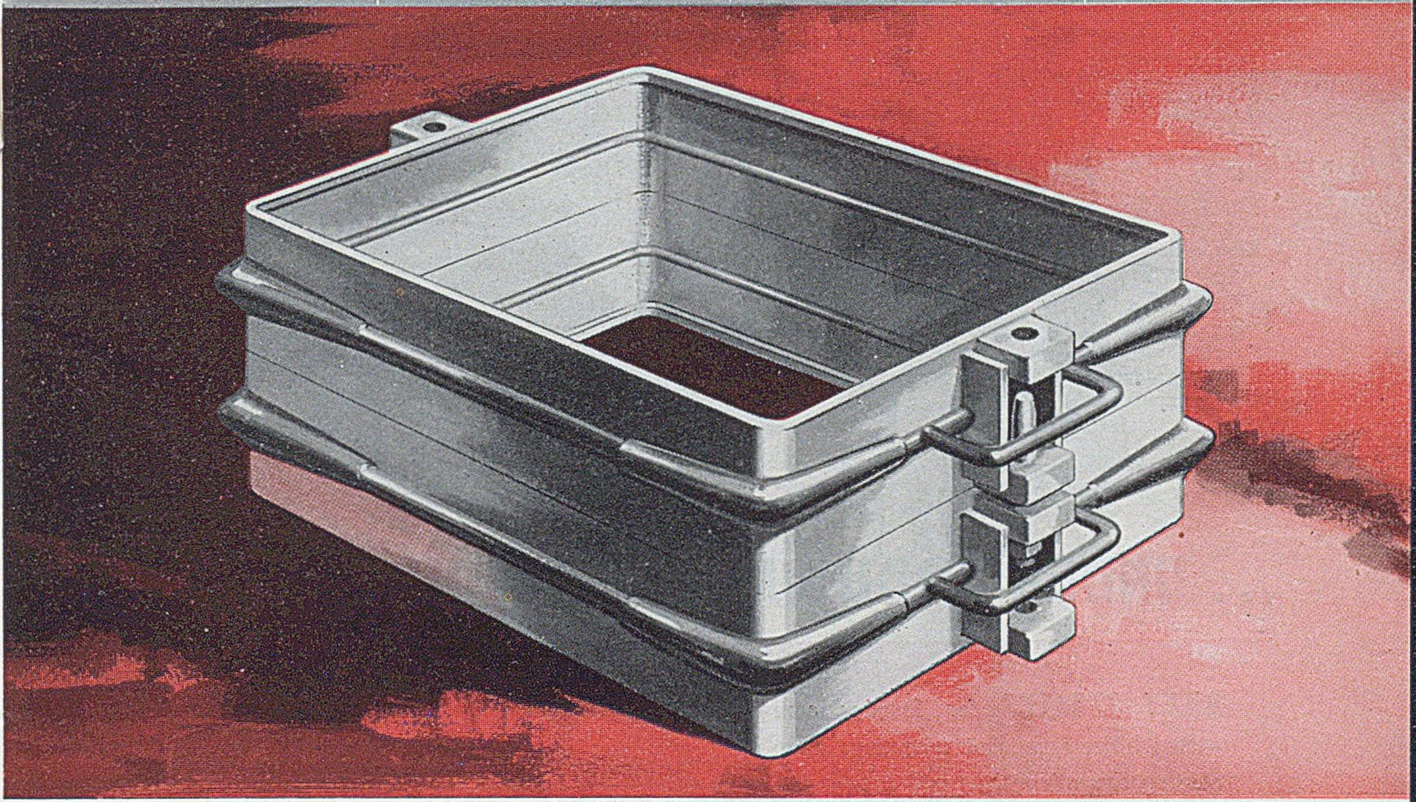
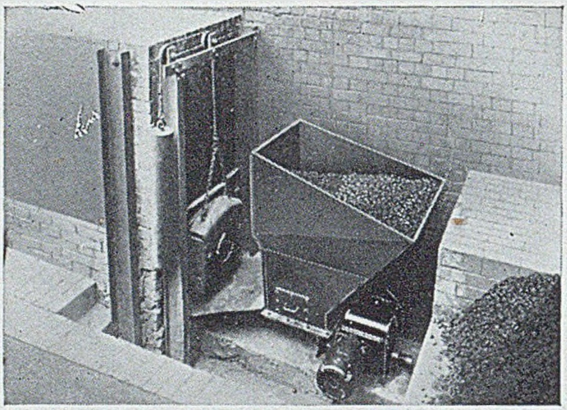
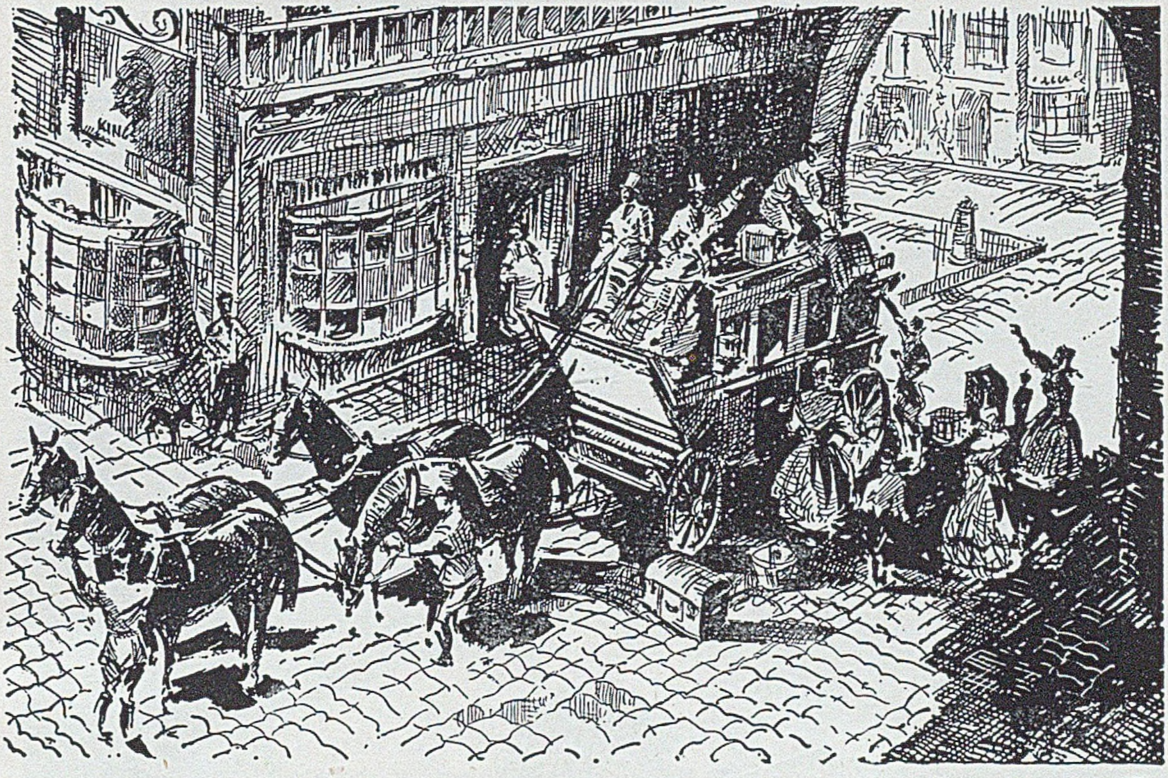




A Riley Stoker firing a Foundry Core Oven.



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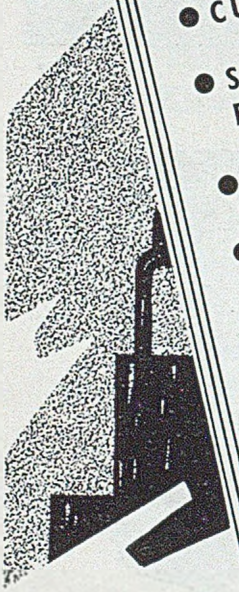

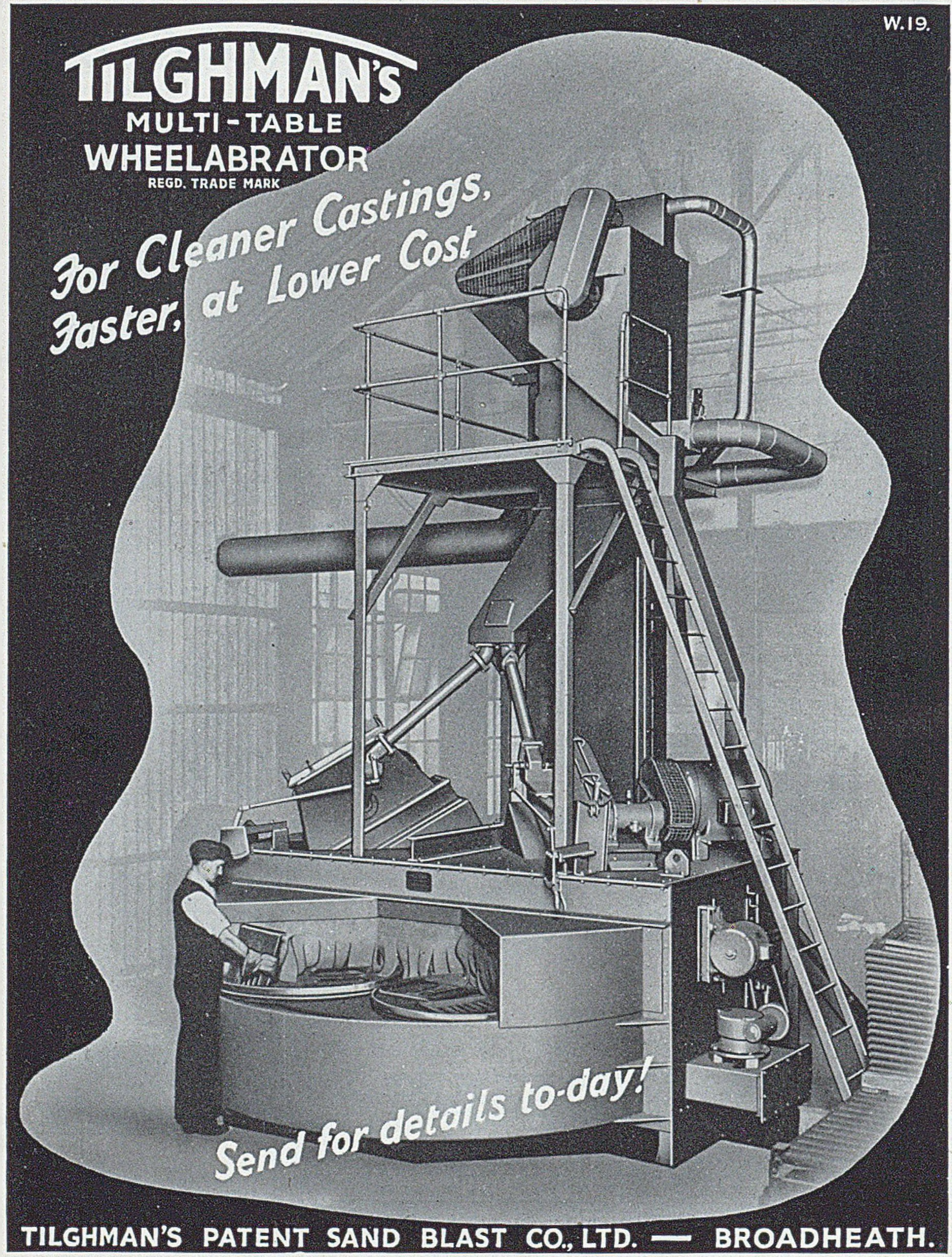
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WHEELABRATOR
REGD. TRADE MARK
For Cleaner Castings,
Faster, at Lower Cost
Send for details to-day!
TILGHMAN'S PATENT SAND BLAST CO., LTD. — BROADHEATH.

OUTSTANDING ECONOMIES ARE BEING OBTAINED

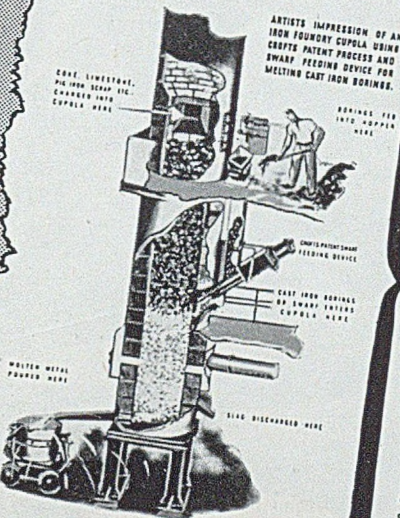
BY USERS OF

June 5 1952 Foundry Trade journal

"CROFTS PROCESS"

WORLD PATENTS APPLIED FOR

FOR MELTING CAST IRON BORINGS OR SWARF IN IRON FOUNDRY CUPOLAS



- We take pleasure in introducing to the foundries of the World our New and Novel Process for Melting Cast Iron Borings (or Swarf) in Iron Foundry Cupolas.
- "CROFTS PROCESS" IS FULLY PROTECTED (WORLD PATENTS APPLIED FOR) AND CAN BE USED ONLY UNDER CROFTS' LICENCE AGREEMENT.
- The operating principle is both simple and economic and, in brief, consists of directly injecting Cast Iron Borings into the Cupola at a position just above the Melting Zone whereby the weight and mass of the normal Charge prevents the ejection of the Borings by the Cupola blast. The Cast Iron Borings immediately enter the Melting Zone and are rapidly heated to their melting point and merge with the molten metal and slag produced from the solid metal charge, this cuts to the minimum the period when oxidation of the Swarf and sulphur absorption may take place.
- The Patented Apparatus is designed specially for use with "CROFTS PROCESS" and is purchased outright. Early delivery can be effected following receipt of full particulars of the Cupola to be converted, the Apparatus can be quickly and easily fitted.
- FULL INFORMATION IS AVAILABLE TO ALL INTERESTED COMPANIES UPON REQUEST.

A LARGE NUMBER OF INSTALLATIONS ARE NOW IN SUCCESSFUL OPERATION IN FOUNDRIES THROUGHOUT GREAT BRITAIN. MELTING CAST-IRON BORINGS AT THE RATE OF *MANY THOUSANDS OF TONS PER ANNUM* WITH GREAT BENEFITS AND FINANCIAL SAVINGS TO THE USERS . . . ONE COMPANY ALONE IS SAVING UP TO £12,000 YEARLY.

INSTALLATIONS ARE ALSO IN OPERATION IN EUROPE AND NORTH AMERICA.
EQUIPMENT IS BEING SHIPPED ALL OVER THE WORLD.

● WE SHALL BE GLAD TO FORWARD FULL PARTICULARS TO ALL COMPANIES WHO HAVE QUANTITIES OF CAST IRON BORINGS AVAILABLE AND ARE INTERESTED IN THE ECONOMIES EFFECTED BY "CROFTS PROCESS" FOR UTILISING THIS MATERIAL.

Crofts (ENGINEERS) LTD.

BRADFORD · YORKS · ENGLAND

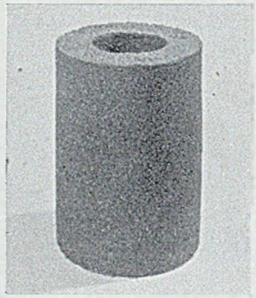
Tel: 65251 (15 lines) Grams: "Crofters Bradford"

Foseco News Letter

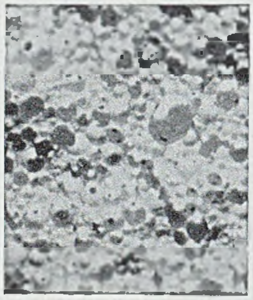
Published by FOUNDRY SERVICES LTD., Long Acre, Nechells, B'ham. 7.

SOUNDER CASTINGS WITH SMALLER FEEDING HEADS

Heat producing materials for lining and hot-topping feeding heads to give more efficient feeding in both ferrous and non-ferrous casting are well-known, and FEEDEX Exothermic Feeding Compound is in daily use in large and small foundries throughout the country. This mouldable compound is available in various grades for use with light and heavy non-ferrous metals and with iron and steel.



Above—FEEDEX heat producing sleeves.



Above—Showing porous, high permeability texture of KALMIN sleeve.

Right—KALMIN Insulating plaster sleeve.

FEEDEX Sleeves now available

FEEDEX, first supplied in powder form only, can now be obtained also as prefabricated sleeves. They can be had in a range of sizes or made exactly as you require them—in your own core boxes if desired.

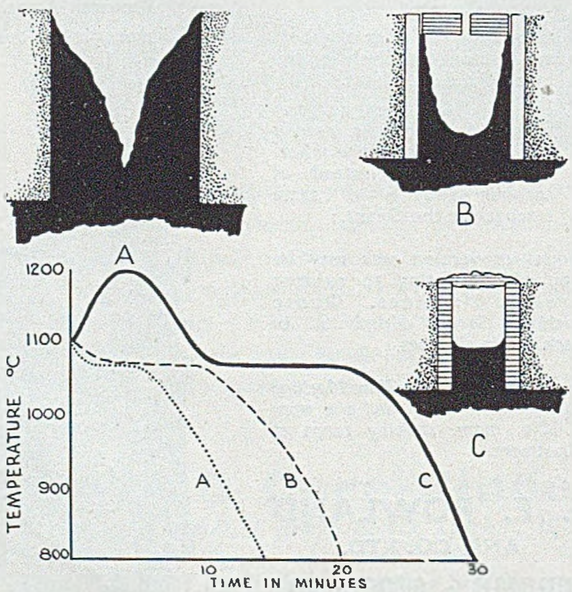
KALMIN Insulating Plaster Sleeves

A more recent addition to our range of feeding materials is KALMIN Insulating Plaster Sleeves which, although not as efficient as FEEDEX is recommended for use with certain non-ferrous alloy castings, particularly in those cases where the feeder head is favourably situated and is filled with really hot metal. It has been proved that the efficiency of such insulating sleeves is considerably improved if a hot-topping plug of FEEDEX is placed on the metal surface as shown in Figure (*b*).

Comparative Efficiency

The illustrations show the approximate relative size of head required with (*a*) unlined head, (*b*) head lined with KALMIN Plaster (with FEEDEX hot-topping plug), (*c*) head lined with FEEDEX (with hot-top of FEEDEX), and illustrate clearly the comparative efficiency of the three methods.

The temperature of metal in feeding heads surrounded (*a*) with sand, (*b*) with a KALMIN insulating sleeve, and (*c*) with a FEEDEX heat-producing sleeve, were recorded, and the results are shown in the graph. It shows clearly the superiority of FEEDEX over the plaster material and the superiority of plaster over the green sand.



Please send further information on (*a*) FEEDEX (*b*) KALMIN

Attach to your letterheading and post to:

FOUNDRY SERVICES LTD.

Long Acre, Nechells, Birmingham, 7.

Tel: EAST 1911 (10 lines) Grams: KUPRIT, B'HAM 7

No.2.

L.G.B.

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Aluminium Alloys find most of their applications in those industries which are of vital importance to both the national economy and defence. The promotion of such applications for Aluminium Casting Alloys is one of the main objectives of ALAR — a non-trading organisation — whose free Advisory Service is available to all users of these alloys.

ALAR

A Technical Association of Light Alloy Refiners

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ALAR, 3 Albemarle Street, LONDON, W.1

Tel. MAYfair 2901

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Established 1902
WITH WHICH IS INCORPORATED THE IRON AND STEEL TRADES JOURNAL

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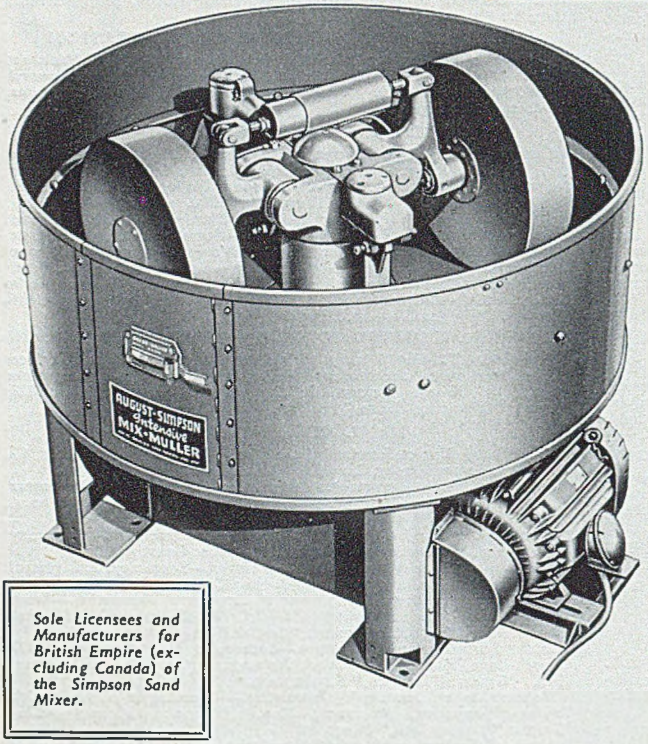
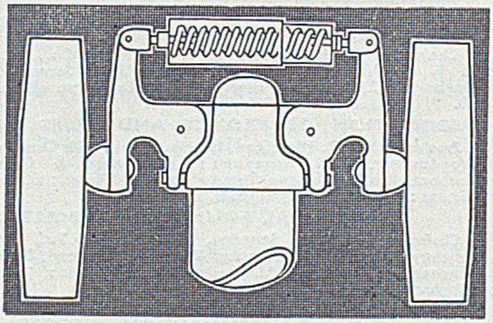
August's PERFECT PLAN FOR MIXING

THE NEW 2F and 3F AUGUST-SIMPSON Intensive MIX-MULLERS



Sole Licensees and Manufacturers for British Empire (excluding Canada) of the Simpson Sand Mixer.

Developments in sand research and in new bonding materials have definitely indicated a trend toward greater mulling pressures. August's have now the perfect answer to this problem in the new 2F and 3F August-Simpson Mix-Mullers, which makes possible increased muller pressures with a minimum of muller inertia. This has been accomplished by using comparatively light mullers and employing a unique spring-loaded muller arrangement which allows complete adjustment for variable muller pressures.



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PRINCIPAL CONTENTS

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Foundry Educational Foundation

The Foundry Educational Foundation is a co-ordinatory body created five years ago in America with three main objectives in view. They are: to foster and improve education in foundry science and practice amongst colleges and universities; to encourage and assist students in acquiring education and training in foundrywork in all its diverse branches and to develop adequate instruction facilities to pursue these purposes. There are no fewer than 27 universities and colleges represented on its technical advisory committee, which is reinforced by 17 representatives of the employers' associations, technical institutes and the Press, together with some persons drawn from the foundry industry. Recently, there has been issued, for the benefit of academic teaching bodies, a complete documentation of the Foundation's activities. Amongst them, in a loose-leaf container, is a series of layouts of foundry departments already installed.

One very interesting activity is the awarding by the Foundation of short-term scholarships to students taking courses at the universities and colleges in various types of subjects allied to the foundry industry, so that interest may be aroused and employment found within the foundry industry to benefit of all parties. The funds available are not to be used for the installation of foundry plant in the colleges. Naturally, the documents provided detail, both graphically and by letterpress, the complicated activities of and the prospects within the foundry industry. There are listed all the subjects taught in the various schools; text-books are recommended and amongst these is included one written by an English author on non-ferrous work. It is truthful to state no phase in the teaching of foundry science has been omitted. Also, amongst the six sections, there is a symposium on casting design and a brochure "Engineers in the Foundry" (the last portion of which lists over 200 concerns which have employed students completing the course in 1952.

The work of the Foundation is of extreme interest to all industrial countries, but applicability in its entirety presents difficulties, when the general educational set-up is studied. The general notion of interesting engineering students and the like by means of a short intensive training in foundry subjects as a means of recruiting high-grade personnel into our industry is one meriting the close attention of all bodies whose activities embrace foundry recruitment, especially of the technical grades. This matter of arousing interest is shown by a chart, where a course from the nursery stage right up to graduation is detailed, starting with the casting of toys as a juvenile distraction. It is interesting to note that the Foundation was created by the American Foundrymen's Society and the employers' associations concerned with the manufacture of grey iron; malleable; non-ferrous and steel castings and the American Foundry Equipment Manufacturers' Association. What they have done is to attack the foundry recruitment problem on a continent-wide basis and, moreover, they have done it with excellent results.

Report on Scientific Policy

The sixth annual report of the Advisory Council on Scientific Policy was published last Thursday. The Council was set up in 1947 under the chairmanship of Sir Henry Tizard to advise the Lord President of the Council in the exercise of his responsibility for the formulation and execution of Government scientific policy. The present chairman is Professor A. R. Todd, F.R.S., professor of organic chemistry in the University of Cambridge. The Report is devoted to a special study of the "Exploitation of Science by Industry," undertaken at the request of Lord Woolton when he was Lord President of the Council. It refers to the need to increase the supply of scientists and engineers for industry. In his speech of June 11 last year Lord Woolton also announced the Government's intention to build up at least one institution of university rank devoted predominantly to the teaching and study of the various forms of technology. This was followed on January 29, 1953, by a further announcement of a proposed major expansion of the Imperial College of Science and Technology and of the Government's intention to make resources available for further developments in other parts of the country. The Council's report emphasizes the great need for a significant increase in the volume of investment in industry. It will be recalled that various measures proposed in the recent Budget were directed to this end.

Among the conclusions of the Report are that (1) modern conditions call for an increasing use of technically-trained men on the Boards of management in industry; (2) for our economic survival in an increasingly competitive world, our industry must put more emphasis on new methods and new processes which depend on engineering and scientific skill; (3) it is an essential condition of our survival that the number of trained technologists employed in industry be greatly increased; (4) the volume of investments in our manufacturing industry is too low, particularly in the development of products and processes. Its increase would do more than any other single factor to assist the better exploitation of science by industry. Among the various possible ways of improving the situation suggested by the Council are greater assistance by research associations, particularly to smaller firms. They hope that the appropriate authority will give further and urgent consideration to the machinery necessary for this extension.

MR. E. G. RUSSELL ROBERTS has been appointed a director of J. & E. Hall, Limited, Dartford.

Latest Foundry Statistics

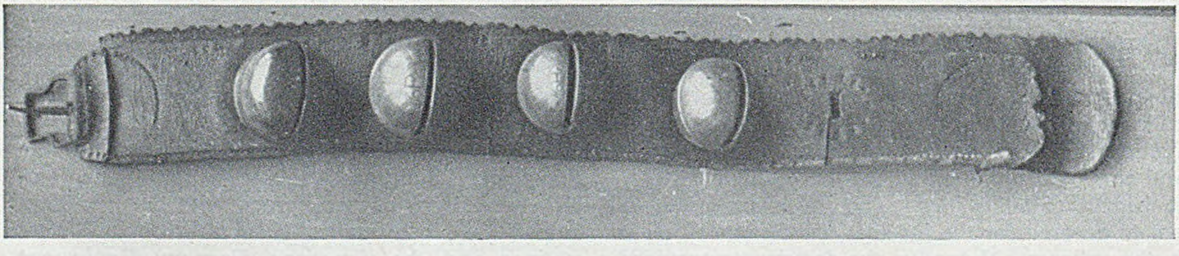
According to the Bulletin of the British Iron and Steel Federation for June, the numbers employed in ironfounding during May again showed a reduction, but not so marked as in the earlier part of the year. The reduction was from 144,805 to 144,034 or 771, (males 721). In steelfounding, too, there was a reduction from 20,868 to 20,756 or 112, but unlike ironfounding there was an increase compared with a year ago of 448 instead of a decrease of 11,876.

The Council of Ironfoundry Association's general bulletin for July also deals with this subject and states that, for the first quarter of this year, employment was 7.1 per cent. less than in May, 1952, which was a peak month. Recession was most marked in engineering and jobbing foundries, whilst automobile founders were adversely affected by the Austin Motor Company strike. The average weekly output of liquid steel for steel castings production during May was 11,100 tons as compared with 10,600 in April, 1953, and 11,300 tons in May, 1952.

According to the British Bureau of Non-Ferrous Metal Statistics the May production of copper-base castings was 43,112 tons. Figures detailing the gross output for the first five months of the year and for 1952 show that there was a decline from 330,329 tons to 240,999 tons.

Castings Reclamation.—A leaflet, taking the form of a letter, has been received from Titecast, Limited, 39a, High Street, Slough, and 123a, Gorton Road, Reddish, Stockport, and makes the appalling claim that they have salvaged 250,000 castings during one year. From what we know of this essentially useful service, there are some foundries which use the sealing process as an insurance. Indeed, the circular refers to "unmachined castings treated as a precautionary measure." The sealing process is now well known, but those who are unfamiliar with it would do well to write for this leaflet to Slough or Stockport.

Fifth International Engineering Congress. This is to be held at Turin from October 9 to 15 and stress is laid on the technological aspects of the programme though the social side is not unimportant. The theme of the congress is "Production and Assembly Methods for Components in Mechanical Engineering." There are no fewer than eleven papers to be given on foundry practice, from authors in seven countries. Details of the congress may be obtained from the British Engineers' Association, 32, Victoria Street, London, S.W.1.



An item incorporated in the newly-opened "Folk Museum" at Shibden Hall, Halifax, is a set of pack-horse bells, fitted to a leather collar, illustrated above. The bells are inscribed with the initials "RW," signifying Robert Wells, a famous south-country bell-maker (1764-99), *who cast his bells in foundries at Aldbourne, Wilts. These bells are of brass, and their melodious chime was broadcast on "Children's Hour" last year. Very few of these pack-horse bells now remain.*

Operating Experiences with Hot-blast Cupolas in Great Britain*

By F. C. Evans, F.I.M.

Many foundrymen in Great Britain are interested in hot-blast cupolas, but, so far, they do not seem satisfied that they will obtain the results that are claimed or that they will be of advantage. In Europe, apart from Great Britain, there has not only been great interest in hot-blast cupolas, but a very large number of installations, probably nearly 100 by now. The United States is also showing interest in blast at higher temperatures than hitherto—of up to 500 deg. C., after a later start than Europe, and altogether there has been a fair quantity of information given in various technical journals, quoting practical experience with hot-blast in the region of 500 deg. C. In Great Britain, however, there are only four hot-blast cupolas working, with another in construction.† All of these are of recent installation and this article is in the nature of a progress report to show what results have been obtained, so far, using British fuels and raw materials and operating under British conditions. The information given will show that the results here in Great Britain are very much the same as the results obtained elsewhere and that claims based on Continental practice are applicable here.

Initially, the main claims for hot-blast at about 500 deg. C., made by Continental and American operators, can be summarized in a concise and practical form, as follow:—

(1) 25 to 30 per cent. decrease in coke consumption.

(2) Greater carburization of steel scrap, which enables steel scrap to replace pig-iron in the charge.

(3) Lower silicon and manganese losses.

(4) Lower sulphur contents.

(5) Increased tapping temperatures.

(6) More-fluid iron.

(7) Increased output for a given cupola cross-sectional area.

(8) Simplified cupola control.

As mentioned in the foreword, there are four hot-blast cupolas operating in Great Britain, but this Paper will only deal with three of these. The fourth plant is probably of the least general interest due to its specialized nature. This plant is operating in a centrifugal-pipe foundry where the coke consumption was already very low due to the low-temperature iron required and where savings in the cost of the charge were not of great importance due to the necessity to use a very high proportion of pig-iron. With this plant, therefore, hot-blast could not expect to show very great advantages and it is probably not a very suitable application.

The other three plants which are operating are of widely varying application and are all of different design. An examination of the results obtained, therefore, covers a fairly wide field and should indicate performances in further applications.

* Paper presented to the London branch of the Institute of British Foundrymen, Mr. D. Graham Bisset presiding. The Author is a director of Metallurgical Engineers, Limited, London.

† As at February, 1953.

FIRST PLANT

The first plant to be put in operation in this country, now over two years ago, was of a simple type in so far as the air was heated separately and not by recuperative means. The plant is installed in a malleable foundry and produces about 70 tons of iron per day. The general layout of the plant is shown in Fig. 1, whereby it will be seen that the air heater is connected to three cupolas, only one of which can be run at one time. The cupolas are of the normal type, connected to fixed receivers.

The air is heated in a gas-fired Schack tubular recuperator, which can be controlled to give any desired hot-blast temperature up to 500 deg. C. In those portions which reach the higher temperatures, the recuperator is constructed of special steel, and consists of tubes through which the air is passing, while the heating gases, suitable baffled, pass over the outer surfaces. The tubes are welded into both upper and lower tube-plates and, while the lower tube-plate is fixed, the upper tube-plate is free to move with the expansion and contraction of the tubes as they are heated or cooled. Waste-gas recirculation is employed to give maximum thermal efficiency and the general compactness of the plant is particularly suitable in foundry conditions. The hot-blast line and wind belts are insulated, so as to restrict the temperature drop to beween 15 and 20 deg. C. from the recuperator outlet to the cupola.

It is interesting to note, also, that the three cupolas shown were originally cold-blast cupolas and that the only alterations necessary when installing hot blast were the insulation of the wind belts, provision of special hot-blast valves and modification of the tuyeres and poke holes, so as to allow for easy opening, when hot. The cupola also had to be reduced in internal diameter to 32 in. to retain the desired output of 6.2 tons per hour, while the tuyeres, six in number in a single row, were increased to a total area of 120 in., giving a tuyere ratio to cupola cross-sectional area of 1 : 6.7. As previously mentioned, this plant is producing whiteheart malleable iron and the effect

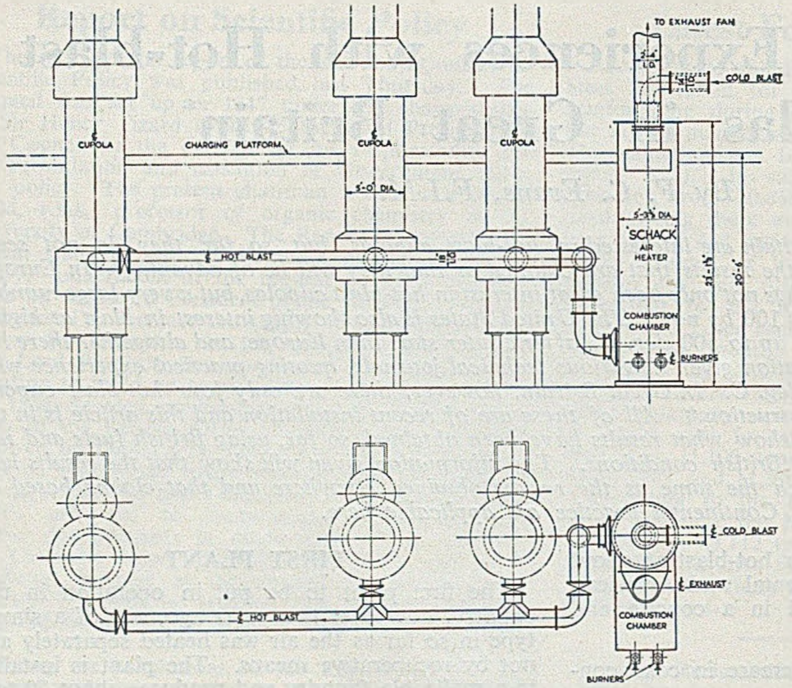


FIG. 1.—*General Layout of the Three 7 tons per hr. Cupolas of the First Plant described. This Plant uses an Independently Gas-fired "Schack" Air Heater delivering* 3,300 *cub. ft. per min. at* 500 *deg. C.*

on the composition of the charge, coke consumption, analysis, etc., is summarized in Table I.

TABLE I.—*Effect of Hot Blast on the Production of Whiteheart Malleable Iron.*

	Cold blast (per cent.).	Hot blast (at 425 deg. C.) (per cent.).
Charge Composition—		
Hematite pig-iron	4.2	4.2
High-Mn pig-iron	1.5	—
Return scrap	66.0	66.0
Steel scrap	25.8	28.3
Fe-Si and Fe-Mn	2.5	1.5
Coke	14 to 14.5	10 to 10.5
Limestone	3.65	2.75
Silicon loss	15.0	0.0
Mn loss	38.0	29.0
Carbon content	3.0	3.1
Sulphur content	0.2	(0.16)*
Tapping temperature (average)	1,495 deg. C.	1,510 deg. C.

* In practice maintained at 0.2 per cent. by gypsum additions.

Working Results

The figures shown in the Table, both for cold and hot blast, are based on stock returns over considerable periods and, therefore, reflect the average charge composition. At times, with hot blast, more steel scrap was used, but this could not be maintained due to shortage of supplies. The ferro-alloys used were normally a 10 per cent. Fe-Si and a 50 per cent. Fe-Mn and, therefore, apart from the 27½ per cent. saving on coke, the main savings were 1 per cent. of Fe-Si, the 4 per cent. Mn pig-iron and the use of a greater proportion of steel scrap. Blast temperature is always maintained at 425 deg. C., although the plant is capable of delivering up to a maximum of 500 deg. C. If, however, the blast is used hotter than 425 deg. C. a silicon pick-up is obtained as against the equilibrium now experienced. With cold blast on the same cupolas, a 15 per cent. loss was experienced.

It will be seen that, in the composition obtained with hot blast, the sulphur is still maintained at 0.2 per cent. However, as indicated by the footnote, sulphur is only maintained at this figure by the addition of gypsum to the charge, when using hot blast. If this is not added, the sulphur content falls to about 0.16 per cent. because of the lowered coke consumption. The iron is also noticeably more fluid with hot blast, and this is attributed to the higher carbon content and the higher tapping temperatures; whatever the cause, the greater fluidity has materially reduced the quantity of scrap within the foundry due to short runs, etc. With cold blast and a coke consumption of 14½ per cent., the average tapping temperature was 1,495 deg. C., while with hot blast at 420 deg. C. and a coke consumption of 10½ per cent. the average tapping temperature is 1,510 deg. C.

The coke used is Welsh Navigation, obtained from the National Coal Board, which has the usual analysis of 88 to 89 per cent. fixed carbon, 7 to 8.5 per cent. ash, 0.6 per cent. sulphur and varying moisture, probably averaging about 5 per cent. The charge materials were basically the same for hot- and cold-blast practice and, therefore, all the figures are strictly comparable. The manganese loss is about 29 per cent. with hot blast as compared with 38 per cent. for cold blast. All the figures quoted are based on over two years' working and are stabilized figures reached after a small experimental campaign. Unfortunately, as this foundry is a production foundry, which relies on this hot-blast plant to produce all the iron required, there are not many other figures available which might be of interest—such as, what metal temperatures could have been obtained with the cold-blast coke consumption figure, how much steel scrap could have been added to maintain 3.0 per cent. carbon, etc.

Other Details

The heater is fired by town's gas of 450 B.T.U.'s gross and the average consumption per hour is 6,350 cub. ft. or approximately 1,000 cub. ft. per ton for an average blast volume of 2,200 cub. ft. per min. This is an all-in average consumption and represents an overall thermal efficiency of 67.5 per cent. The heater, as a unit, actually has an efficiency of about 80 per cent., the 12.5 per cent.

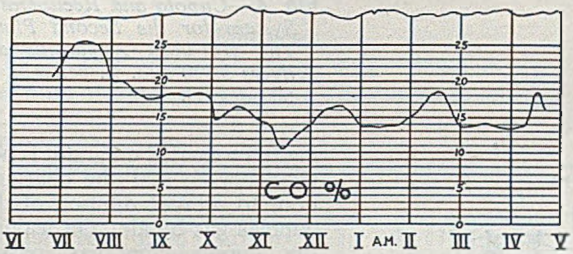


FIG. 2.—*Hourly Variation of Cupola Top-gas Analysis when employing Hot Blast. The CO Content plotted is derived from the CO_2 Content actually recorded.*

loss in efficiency being expended in starting up daily from cold, temporary shut-downs, etc. The cupola is in operation five days per week for 10½ hrs. per day. ; The normal practice is to blow up the bed with the blast while it is being heated from cold to 425 deg. C., an operation which only takes 20 min., starting from cold. With this practice, there is no need to boost the coke percentage in the early charges.

Reports from the Continent and elsewhere have indicated that hot-blast working was much more severe on the refractories than cold blast. In this particular plant, supplies of German patching material have been imported and are now used for repairing the cupola. Originally, however, a Derbyshire white silica patching was used with good results and it was only the failure to obtain satisfactory supplies of this which led to the importing of the German material. The refractory consumption per ton of metal melted is not recorded separately from that of the whole of the melting plant and it includes, therefore, the patching material for the receiver and ladles also. With cold blast this total consumption was 88 lb. per ton of metal melted, while with hot blast this actually dropped to 62 lb. per ton.

Within the melting zone itself, the erosion is deeper, being approximately 6 to 6½ in. per 10-hr. day for hot blast as against 5 to 5½ in. for cold blast, but, on the other hand, with cold blast the erosion is spread over a much larger area. With hot blast, the melting zone is shallow and there is no erosion above 4 ft. from the tuyeres.

Performance Assessment

This plant has been working long enough for an accurate economic appraisal to be given of its performance. From Table I some assessment can be made as to the economy which has been made on the cost of the charge. From this and from the figures for gas consumption, and because the other running costs of the cupolas are not different from those with cold blast, these two factors only have to be taken into consideration in assessing the value of the hot-blast plant.

The price of gas is, of course, a crucial point in this plant and the initial calculations which were made were somewhat upset in practice by the price per therm being advanced by about 40 per cent. soon after the plant was put into operation. As matters stand to-day, therefore, the plant is showing only approximately half the net gain per ton in the cost of iron melted, which was originally calculated, the lower saving being mainly due to the increase in the cost of gas, but also partly to a "famine" of steel scrap.

When the plant was originally planned, the price of gas made a gas-fired air-heater attractive, both from the point of view of running cost and capital cost. As it stands at the moment, however, the price of gas is a grievous burden and naturally the question of a plant using waste cupola gas for fuel is now being investigated. Measurements made on the plant have shown that such a plant could be run quite satisfactorily and this would, of course, dispense with the cost of the gas. The results of these tests are also very interesting as they give the exact calorific value of the top gas of a hot-blast cupola and, therefore, the answer as to whether a hot-blast cupola, working on British foundry coke, can be run completely on a recuperative cycle. The temperature of the gas leaving the top of the charge averages 200 deg. C. and a typical day's analysis of the gas is given in Fig. 2, which shows the equivalent calculated CO value derived from the CO_2 recorder. From this, it will be seen that the CO value never drops below about 10½ per cent. and that during the majority of the day it is running at considerably higher values.

In Fig. 3 is shown the method of calculating the total quantity of heat in the top gas, and from this it will be seen that the calorific value of the gas at 10½ per cent. CO never falls below about 42 B.T.U. per cub. ft. and for the majority of the day it is considerably greater. As a hot-blast plant for delivering hot blast at 500 deg. C. can be designed which will operate adequately on gas producing 40 B.T.U. per cub. ft., there should be no difficulty about running this plant using stack gas,

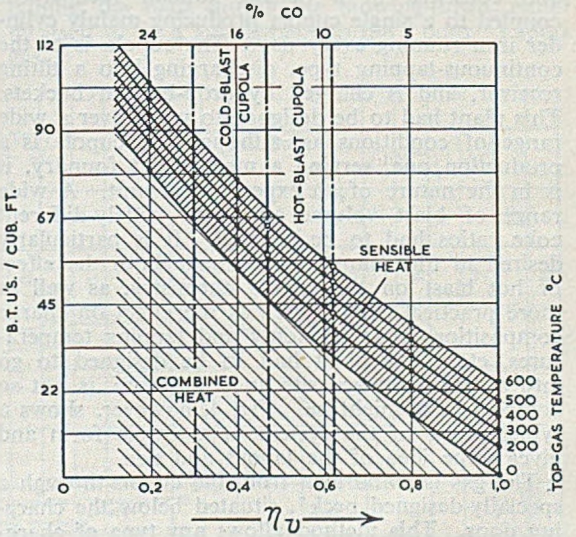


FIG. 3.—*Graphical Method of Calculating the Heat Available from Cupola Top Gas.*

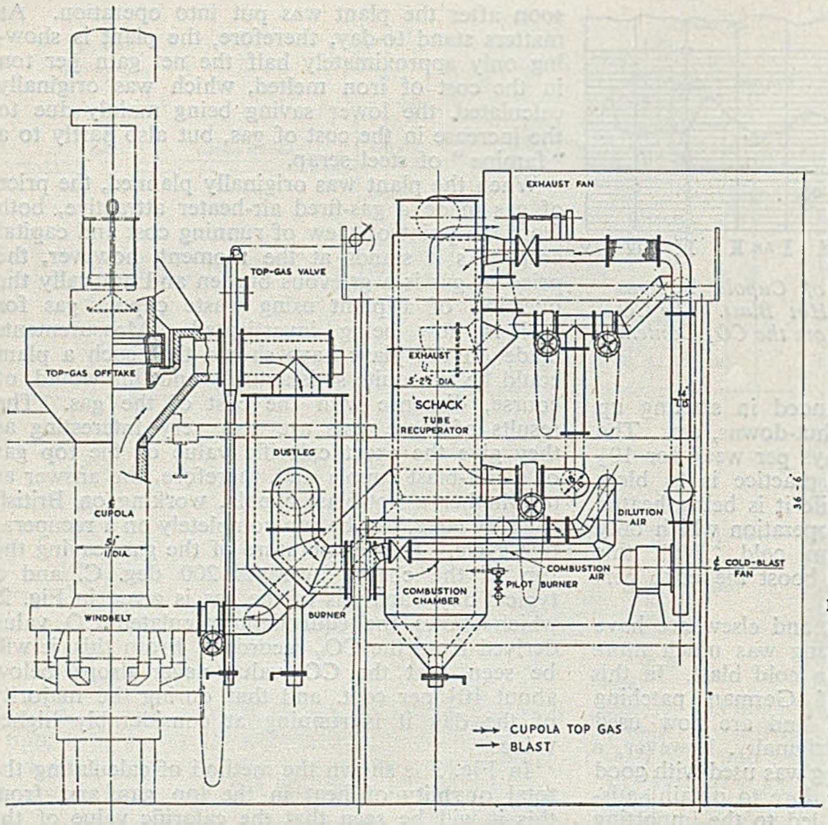


FIG. 4.—*Cupola and Recuperator System for the Second Plant. The Hot-blast Apparatus delivers* 3,500 *cub. ft. per min. at* 500 *deg. C.*

especially as the blast is not required normally to be more than 425 deg. C.

SECOND PLANT

The second plant to be put in operation in this country was during last summer, August, 1952, and consisted of a Schack tubular recuperator coupled to a single cupola producing mainly cylinder iron running every day. The cupola is of the continuous-tapping type, discharging into a tilting receiver, and is charged by drop-bottom buckets. This plant had to be designed to work over a wide range of conditions as, although the cupola is a production one, serving a mechanized foundry, it is in the nature of an experimental unit. A wide range of blast volume and with widely-different coke ratios had to be covered. It is particularly desired in this plant to investigate both the effect of hot blast on the cupola chemistry, as well as more practical details, such as the effect on charge composition, coke economy and tapping temperatures, etc. The plant had to be designed to go into a very awkward site and, therefore, is not so compact as it might be. Fig. 4, however, shows a typical view of the system in a simple form and gives some idea of the layout and size.

The gas is withdrawn from the cupola through a specially-designed neck*, situated below the charging door. This method allows any type of charging to be carried on and it is not necessary to seal the charging door to prevent dilution of the cupolas gas by air. On leaving the cupola, the gas passes through an insulated main to retain the sensible heat, to a dust "leg," which removes the majority of the entrained dust.

Between the cupola and the dust "leg," there is a special valve for isolating the plant when necessary. The gas passes to the recuperator firebox and before entering has combustion air injected into it through a special burner. Inside the firebox, combustion is initiated and maintained by a small pilot gas burner. After combustion, the gases, at about 850 deg. C., pass through large-diameter, vertically-disposed tubes to the top casing, from which they are withdrawn at about 450 deg. C. by an exhaust fan which passes them out to atmosphere through a chimney. The cold blast from the main blower passes over the outside of the tubes, which have suitable baffles, in a contra-flow direction, *i.e.*, from top to bottom of the recuperator, and thence through an insulated hot-blast main, provided with special valves, to the cupola wind-belt which is also insulated externally with slag-wool. The blast system is also provided with a by-pass system for running the cupola on cold blast if required, and a blow-off valve can be arranged to eject hot air into the exhaust system, should it be necessary to bleed off hot blast during a temporary shut-down.

The firebox temperature is maintained below a dangerous figure by the dilution-air system whereby a pyrometically controlled valve introduces cold air at a pre-set temperature. The dilution air and combustion air are supplied from a separate fan. Although the majority of the dust is separated out by the dust-trap, some passes on and coats the inside surface of the tubes, thereby, in time, reducing the efficiency of the recuperator. To clean the tubes, the top cover of the exhaust-gas casing on the recuperator is removed and flue brushes are passed down through the tubes. The dust falls into the conical bottom of the combustion chamber, from which it can be withdrawn through the slide valve in a similar manner to the dust from the dust trap. The whole plant is compact and reasonably light and, in this case, has been mounted above floor level so as to leave floor space free for operations such as ladle heating, drop removal, etc.

* British Patent No. 662325.

Efficiency

This plant is capable of heating 3,500 cub. ft. per min. of air to 500 deg. C. The cupola to which it is connected is normally lined to 31 in. i.d. A unique feature about the cupolas, where this plant is installed, is that a short-cycle blast-furnace coke is used. This coke has the following approximate percentage composition:—Water, nil; volatile matter, 0.6; fixed carbon 87.3; ash, 12.1; and sulphur, 0.98. Physically, the coke is small, the average size being about 2½ in.; it is soft and has a low "shatter" figure, and the absence of moisture is noteworthy. It was found in practice that, with high coke rates of, say, 6½:1, the top gas was exceedingly rich, a figure of 21.5 per cent. CO being registered during one test. It was, therefore, necessary to work the plant over a very wide range of calorific value of the top gas. So far, the lowest value recorded has been about 12 per cent. CO and the highest about 24 per cent. CO—or, in terms of B.T.U. per cub. ft., 51 to 92 (including the sensible heat at about 300 deg. C.). Making the plant work over this wide range of calorific value and the necessity at times to operate the plant with blast volumes as low as 1,200 cub. ft. per min., or 35 per cent. of the plant capacity, led to some initial difficulties which have now been successfully overcome.

The cupola top gas from this blast-furnace coke was also found to be very full of dust of a very light nature. As will have been seen from the composition, the total ash content is considerably greater than for normal foundry coke, but it would seem that the ash of this blast-furnace coke is of a somewhat different nature to that of Welsh Navigation coke. More will be said about this later, when comparing it with the third plant to be described, in which Welsh Navigation coke is used. The very dusty nature of the gas led to some problems with combustion, particularly at low-CO values, and the very light, flocculent nature of the dust tends very quickly to cause the build-up of an insulating blanket of the face of the tubes. On the other hand, this light, flocculent dust has shown no signs of fritting on to the tubes, as can take place with some types of ash.

No difficulty is presented in obtaining, at any blast volume, the blast temperature of 500 deg. C. which was specified, provided the tubes are clean. There seem to be ample calories in hand at 12 per cent. CO to produce blast at 500 deg. C. over the full range of volume, and one of the main difficulties arose from overheating of the plant with the very high CO values of about 24 per cent. It has been found necessary, however, at the maximum volumes of about 3,500 cub. ft. per min. to clean the tubes daily to maintain the blast at 500 deg. C., an operation which takes one man ¾ hr.

Novel Cleaning Trials

The normal method of cleaning the tubes is, as described, to remove the top cover of the recuperator and clean each tube by pushing down a brush from above. Trials are being made, however, with a method of cleaning the tubes while the apparatus is working. This is very simple, and consists of throwing wood chippings into the fire-box through a cleaning door. These chippings catch alight and are drawn up by the draught through the tubes. They pass up in a spiral path and as they do so they dislodge the dust, which is carried out by the upward draught. Initial experiments have shown good results and trials are proceeding to find the right size of chipping, which will not be too heavy to be drawn up and yet not too light to be burnt before it reaches the top of the tube. By this method, hand cleaning after plant shut-down will not be necessary and it will be possible to run an apparatus continuously if desired.

Initial Heating

When designing this plant, it was specified that the blast should be at operating temperature within as short a time as possible after starting. To enable this to be done, a pre-heating burner was added at the firebox, whereby the recuperator could be warmed up with coke-oven gas before starting to blow the cupola. Conversely, it was also desired that the blast should maintain its temperature to as long as possible before the "drop" in the afternoon and the same burner could be used for maintaining the blast during the blowing-down, either by itself or as a supplement to the "poor" cupola gas.

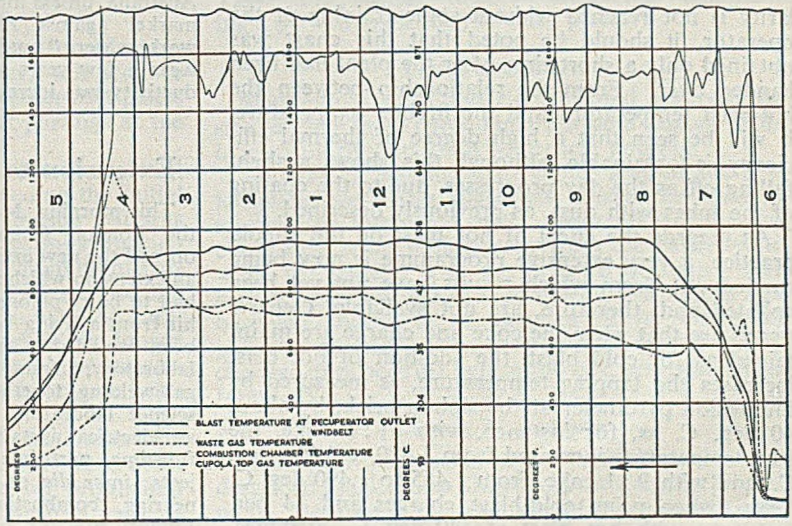


FIG. 5.—*Temperature Record Chart for a Typical Day's Working of the Second Hot-blast Cupola Plant described, which employs a "Schack" Convection/Tubular Recuperator.*

Operating Experiences with Hot-blast Cupolas

As regards the latter, it was thought that, as soon as the charge level dropped below the gas take-off neck, a mixture of gas and air would be withdrawn into the cupola top-gas main. This, it was conjectured, would lead to burning of the top gas in the top-gas main, with subsequent loss of calorific value at the recuperator and also some damage to the main itself. It was, therefore, believed that it would be necessary to stop running the recuperator on top gas, as soon as the cupola charge level fell below the take-off neck. Fig 5, however, shows the temperature records from a typical day's working of this plant and from this it can be seen that without the use of the pre-heating burner, blast at 500 deg. C. was not obtained until about 1½ hrs. after the start of blowing (chart starts on right-hand side). If the pre-heating burner is used for about 1½ hrs. before starting, blast temperature of 500 deg. C. can be obtained within 5 mins. of the start of blowing. Unfortunately, this gas has not yet been metered, but from the burner capacity it is calculated to be between 1,000 and 2,000 cub. ft. The graph also shows that the blast temperature was maintained to within about 5 mins. of the drop at 4.30 p.m. and for this a gas addition was not necessary.

Practical Findings

It is the practice, also, on this cupola to run the cupola on reduced blast during the dinner-hour and it was found that this plant maintained 500 deg. C. on this reduced blast very easily, without any change of the controls. At lunch-time, blast volume is switched down to approximately one quarter of the rating of the plant, *i.e.*, about 900 cub. ft. per min., and the plant is left. It will be seen from Fig. 5 that the blast temperature during the luncheon period, 11.30 a.m. to 12.30 p.m., rises slightly.

The easy way in which the blast temperature is maintained will be noted and, although this regularity is not reached without some training of the operator, it should be noted that this chart was obtained only a short time after the plant had been handed over. From the relationship between the hot-blast temperature and the firebox temperature, it will be seen that a high degree of thermal efficiency is obtainable, although this shows a slight falling off as the day progresses, due to the coating of the tubes with dust, as previously described.

As regards the effect of hot blast on the cupola practice, a very extensive programme is now being carried out, from which results have not yet been collated and, therefore, are not available. General trends are that when the coke and charge are maintained as for cold blast, the addition of hot blast increases the tapping temperature, as measured by immersion pyrometer at the siphon brick, by about 40 deg. C. as, for instance, with 6½ : 1 coke, the iron temperature increased from 1,470 to 1,510 deg. C., and with 9 : 1 coke, from 1,455 to 1,490 deg. C. Again, when using cold-blast charges and 14 per cent coke with hot blast at 440 deg. C., averages from scattered runs have shown that total carbon content in the iron increases from 3.37 to 3.49 per cent. and that silicon also shows a slight increase as against the previous 5 per cent. loss. Sulphur, on a similar basis, has shown an average of 0.111 per cent. with hot blast as against 0.126 per cent. for cold blast. From this basis, the foundry is going ahead with finding out how to obtain the same composition and tapping temperature with hot blast as was obtained with cold blast and assessing the charge economies possible, but from the results already obtained it would seem to be possible to increase the steel in the charge by at least 7½ per cent. in place of pig-iron.

(To be continued)

Australian Import Relaxations

Further relaxation of import controls was announced by the acting Prime Minister of Australia recently. Appropriate adjustments will be made regarding goods licences under administrative arrangements. Category A goods, which have been licensed on the basis of 70 per cent. of the base year 1950-51, will be licensed on the basis of 80 per cent. of that year. The licensing of Category B goods will be raised from 30 to 40 per cent. of the base year.

Progressive reduction of Australian quota restrictions on the import of British goods was forecast in Birmingham by Mr. S. F. Ferguson, director of the Australian Association of British Manufacturers, when he addressed the Birmingham Chamber of Commerce. At the same time, he warned that Australian manufacturers are likely to fight hard to have the tariffs against British imports raised, as for the past 18 months the spiral of inflation in Australia had made her manufacturers unable to compete with British goods. Recalling the news quoted earlier that the permitted quota of categories A and B British goods going into Australia had, lately, been increased, Mr. Ferguson forecast a similar relaxation for the third category (essential material and equipment) where each application was judged on its merits. He said he would not advise British firms to open factories in Australia, unless they had no other hope of holding their market against Australian competition. Australian workers were " much less independent " to-day than they were a few years ago, when jobs were plentiful. Productivity was increasing.

Extension to Poplar Technical College

This morning, Mr. R. McKinnon Wood, chairman of the London County Council Education Committee, opened the new extension to Poplar Technical College—an extension which was started before the war, but which had to be re-planned and built anew following a direct hit from a flying bomb in 1944. Accommodation has been provided in the new building for a heat-treatment laboratory, a foundry, a motor-vehicle shop, electric and gas welding, together with an elementary engineering science laboratory, lecture rooms, drawing offices and an electrical installation room. The College provides full-time, part-time and evening courses in such subjects, *inter alia*, as marine engineering, mechanical engineering, combustion engineering, patternmaking and foundry practice.

Shell-moulding Patterns and Possibilities

Impressions from the Congress of the American Foundrymen's Society

In a brief report in *Iron Age* on deliberations at the recent meeting of the American Foundrymen's Society, in Chicago, it is stated that shell moulding is emerging from the strictly experimental stages, as evidenced by the many papers devoted to various phases of the subject. Many foundrymen are exploring specific problems, including sands, resins, testing methods, testing standards, pattern problems, and difficulties encountered in pouring various metals.

Materials

While the jobbing foundryman still has doubts concerning the economic applications of shell moulds, the technical aspects are moving ahead rapidly. Indicative was a report by G. A. Conger, Cambria Foundry & Engineering Division, Stevens Manufacturing Company, Ebensburg, Pa., on the first meeting of the Shell-moulding Materials Testing Committee. The committee programme includes:—(1) A reference sand; (2) cured-strength, hot and cold; (3) mixing procedure; (4) cured-permeability; (5) cured-deflection, hot and cold; (6) sample preparation; and (7) hardness. Tentative standards for tensile evaluation are scheduled for publication shortly. The reference sand is already available.

Aluminium and cast iron are the most common materials for shell-moulding patterns, Mr. Ray Olson, of Production Foundry & Pattern Company, Chicopee, Mass., reported. Generally, the material must stand repeated heating to about 330 deg. C. (600 deg. F.). Pattern or patterns are arranged on plates so that cope and drag match with locators established on the plate surface. The locators create a corresponding condition on the joint face of the two halves of the completed shell mould.

Aluminium Patterns

Aluminium can be processed at a reasonable cost, and a well-cared-for aluminium pattern will produce 5,000 or more shells. Aluminium plaster-cast plates are particularly adapted to irregular partings at the joint of the two shell-mould halves.

In some cases, aluminium patterns can be replaced as often as three times without exceeding the initial cost of cast-iron patterns. Often, master patterns are of machined aluminium, which permits working to closer tolerances. In the use of aluminium patterns, however, care must be used when fastening screws or bolts connecting the pattern with the baseplate, since repeated heating and cooling can loosen the bolts. Coating the screws with a high-temperature lubricant is a good idea, and will decrease heat-caused thread corrosion.

Brass and bronze, or steel patterns, have also been used. Machined steel patterns have been used commercially, with considerable success for production runs of small parts. For long-wearing iron patterns that will take a high finish, a composition of C 3.10, Si 1.90, Mn 0.80, S 0.10 and P 0.10 per cent. has been good. This iron can be annealed at 820 deg. C. for 1 hr. for machinability. Stress-relieved iron plates, ground to ½-in. thickness, have produced excellent results.

Sequences in Manufacture

In some cases, a wooden master pattern has been used with metal shrinkage or machining allowance included. From this, an aluminium master pattern is made. The master is mounted on a plate, and from this pattern shell moulds are produced. Shells are poured with the required pattern material, and the resultant castings are used as a pattern.

Aluminium patterns are easily nicked, often when a shell sticks to the pattern and a shop mechanic uses a screwdriver to prise the shell from the pattern, Patterns should be stored carefully, upright and attached to the baseplate.

O. C. Bueg, Arrow Pattern & Engineering Company, Erie, Pa., divided shell-mould patternmaking into nine steps. The first step is to determine whether or not the part can be produced more cheaply by the shell-moulding process. Assuming shell moulding is economic, the proper alloy for the pattern must then be determined. Aluminium has advantages. Pressure-cast plates are suitable if precautions are taken in construction of the master parting. Where flat partings are used, machined-and-mounted patterns are recommended, since often only one plate is necessary to produce the shell. For long production runs, cast iron offers greater pattern hardness. The cast-iron pattern also has a better heat-transfer value, and seems more adaptable to silicone release sprays.

Pattern surfaces should be finished to a high polish. Thermal expansion should be considered when bolting a pattern to an alloy backing plate.

Gates and Risers

Shell-mould gates and risers should generally be smaller than those needed in green-sand casting. This is particularly important in vertical pouring.

Sand/resin retaining strips on the shell-mould patternplates were also suggested, tapered for ease in ejecting the completed shell. Strips prevent the uncured shell from falling away from the patternplate when the pattern is in the inverted position. For high-temperature use at high speeds, the pattern and baseplate should be of identical alloys. Gates on patterns should be separate, since several gating changes may be tried before the best arrangement is found.

Casting Magnesium

Casting of magnesium alloys in shell moulds was described by Nicholas Sheptak, Dow Chemical Company. Because of the reactivity of magnesium alloys

Shell-moulding Patterns and Possibilities

in the molten state with silica sand, inhibitors were studied. Conventional green-sand casting of magnesium may employ boric acid, sulphur, glycol, and sometimes a flushing of the mould cavity with sulphur-dioxide gas.

In shell-moulding, the sulphur-dioxide flush did not seem particularly effective. Boric-acid additions to the sand/resin mix as an inhibitor had a weakening effect on the shell strength.

BLOWN SHELL MOULDS

A "dark horse" at the American Foundry Association's meeting was the D-process. Using oil in place of resin, Dietert Foundry Company, Detroit, and Archer Daniels Midland Company, of Minneapolis, have developed a new process which may give strong competition to shell moulding. The lower cost of oil-binder as compared with resins is a principal factor in development of the D-process. While no papers were scheduled on the topic, "corridor sessions" covered the subject thoroughly.

The D-process utilizes an oil-binder prepared by the Archer Daniels Midland Company and eliminates the use of a shell-moulding machine, yet produces what is called a shell mould.

Conventional foundry equipment is used to blow the sand/oil mix on to a "contour-drier." The mould must be cured for upwards of half an hour, but is reported to give good mould strength and to be suitable for large shell-mould applications.

A first requisite is a fine, dry core sand. Preliminary work indicates that either a bank sand or a washed and dried Ottawa-type sand may be employed. From 1 to 3 per cent. by weight of a special oleoresinous binder is added to perfectly dry sand.

Contoured Drier

The amount of binder depends upon the type and fineness of the dry sand used. Other sand additives may be incorporated in the mixture for elevated temperature properties; however, the fundamental formula of sand and oil cited above can be used by itself. After blending the binder and sand in normal equipment, the mixture is placed in the hopper of a conventional coreblowing machine and the shell mould is blown on a contoured drier. This drier differs from the normal drier in that it is used to form the back of the shell mould as well as act as support for the mould itself. The drier is vented so that the sand can be adequately packed in it.

No Backing Needed

Normal blowing-machine pressures are used and no other special equipment is necessary. The blown shell mould and drier are placed in a conventional core-baking oven for curing. The time of curing is a function of the mass of sand in the core, its thickness, the type and grain-size of the sand, the amount of binder used, the weight and composition of the drier, and the load in the oven.

Temperatures as high as 330 deg. C. (600 deg. F.) may be used if the time cycle is adequately short. A half-inch shell baked on a drier about 1 in. thick should be thoroughly cured in about 40 min. at 288 deg. C. (550 deg. F.) when 2½ per cent. binder is used with fine, dry bank sand.

Shells are clamped together and cast. No special backing material is necessary, since the thickness of the shell can be so adjusted to prevent the breaking through of the shell by the molten metal.

Experimental Procedure

The following procedure may be used for testing the process: Place 975 lb. of dry, bank sand into a cleaned mixer, run the mixer a few seconds to distribute this fine sand over the base plate, then slowly add 25 lb. of liquid binder to the sand. Mix the binder with sand for a sufficient time to assure complete dispersal. No more than 10 min. should be necessary.

Discharge the sand from the mixer and place it in the reservoir of the cleaned coreblowing machine. Place the drier plate on the machine table and blow shell moulds. Pattern surfaces must be properly cleaned with a solvent such as petrol. Remove the shell mould and drier from the machine and bake the mould in the drier.

Precautions

A few precautions to observe are: (*a*) the mixer should be as clean as possible, before and after discharge of mixed sand. Binder which clings to sides of the mixer must be mixed into the sand; (*b*) mixed sand can be stored in an open area without protection for approximately 24 hr. If longer storage time is necessary, a cloth dampened with fuel oil (not water) can be used as a covering; (*c*) the coreblowing machine lines must be free from water for best results, and (*d*) shell moulds should be blown in as rapid succession as possible, to prevent oxidation of a thin film of binder on the pattern surfaces.

Advantages of the D-process compared to regular shell moulding are said to include: Thickness of a D-process shell can be controlled by the contour of the drier, lessening danger of horizontal section breakthroughs when the shell is cast in a vertical position. Sand reinforcing ribs can be made integrally with the back of the shell. No special foundry equipment is needed other than contoured driers.

THE Engineering and Allied Employers' National Federation has agreed to meet the Confederation of Shipbuilding and Engineering Unions for preliminary talks on July 21 to discuss the unions' claim for a 15 per cent. increase in wages.

A NEW COMPANY, John Dale (Canada), has been formed in Toronto by John Dale, Limited, manufacturers of containers, non-ferrous tubes, and aluminium and light alloy castings, of London, N.11, and Modern Containers, a Canadian undertaking, to operate new plant for the manufacture of metal containers and plastic mouldings, etc. The plant is expected to be in production by the end of the year.

Pressure-cast Aluminium Pattern Equipment*

Discussion of the Paper by D. H. Potts

Questions addressed to the Author at Birmingham and London meetings and his replies are recorded, mainly concerning intricate detail of the processes revealed. The whole substance of the Paper was exhaustively traversed, in considering such subjects as parting agents; alloys and their pre-treatment; plaster characteristics and mixing, costs, production times, pouring and feeding arrangements, baking, metal container and mould assembly and the various degrees of skill required.

BIRMINGHAM BRANCH DISCUSSION

MR. WEAVER proposed a vote of thanks to Mr. Potts and said that the paper had been most interesting. He had, he said, had the advantage of listening to the early part at Harrogate at the Brassfounders' Productivity Conference, and he would like to take the opportunity to congratulate Mr. Potts on his work, and to thank him for coming from Chippenham to present his lecture. He would also like to endorse what Mr. Potts had said in regard to the company for whom he worked, in thanking them for the time they had allowed Mr. Potts for his experiments with this process.

MR. TIPPER said he had very much pleasure in seconding the vote of thanks, because not only had he had the opportunity of seeing Mr. Potts's set-up, but he was sure that the foundry industry as a whole was very much indebted to him for putting so much effort into showing that the process could be a success. One or two visitors to the United States had come back and tried the matchplate process, but had failed to get successful results. Mr. Potts, on the other hand, had proved how simple the process was if certain fundamentals were adhered to.

Plaster Industry Commended

MR. POTTS, in acknowledging all the kind things which had been said, felt he could not let the evening go by without mentioning the full co-operation of members of the British plaster industry, who set about the task of finding suitable plasters for the process and made the whole thing possible. He felt that the foundry industry as a whole owed them a debt of gratitude.

MR. LEE asked how a single pattern was cast under pressure.

MR. POTTS replied that a similar system to that described was followed. The single pattern was embedded in the plaster, and instead of placing a frame around, the mould was closed in and the metal allowed to flow into the single mould. If a number of loose patterns were required to put on machine-moulding plates, or for working "loose," then small individual moulds could be made and then connected up with a runner system, and afterwards split up.

MR. BLYTH said here, in Mr. Potts's paper, was something really practical and constructive emanating from a productivity team's visit. He asked whether the Author had any experience of, or suggestions to make, as to the possibility of using this system of making run-offs, in metal other than aluminium.

MR. POTTS said, providing that the melting temperature of the metal was not higher than that of aluminium, it could be used. He had tried one brass job, by gravity pouring, but got only medium results.

Production Details

MR. MARSH asked whether any alloy other than L33 had been tried, and also whether the 16 hrs. baking time mentioned was sufficient for any size or depth of mould.

MR. POTTS said his firm had standardized on L33, but D.T.D.424 had been tried, with fair success. The baking process, he explained, was developed to meet their own works' requirements, and the patterns concerned were relatively small. In America, some authorities said 12 hrs., and others a double treatment for this period. From personal experience, he said that, as the size increased, so the baking time should increase.

MR. WEAVER asked whether the plates originally shown at the Harrogate conference were in D.T.D.424 alloy, as he seemed to remember they were not so good as the ones now shown. He also asked whether the material was "modified."

MR. POTTS replied that L33 was the alloy used after being de-gassed and "modified."

MR. TIPPER said that Mr. Potts had stressed the necessity for accurately weighing the water and plaster for the mixture, but not only should the temperature of the water be controlled, but also water from a dirty container should not be used. It was necessary, in order to obtain pressure feeding, for the runner to remain liquid until the whole of the casting had solidified, and that meant that the runner must be so dimensioned that it was the last to solidify. Finally, he asked Mr. Potts whether he had anything to say about chills on heavy sections.

MR. POTTS replied that they had not used chills,

* The Paper, both to the Birmingham and London branches of the Institute of British Foundrymen, was presented in two sections; the first substantially as printed in the JOURNAL of July 31, 1952, and the second on June 11, 1953. Mr. Potts is associated with the Westinghouse Brake & Signal Company, Limited.

Pressure-cast Pattern Equipment

but had used very small denseners, the heads of which were no bigger than a 4- or 6-in. nail, made of aluminium by the same plaster process, and pushed into the plaster at the heavy sections.

Mr. Weaver said he would like to have some indication of the cost of the process.

Mr. Potts said that, as he was connected with a "tied" foundry, he was unable to give prices. The single-impression matchplate which he showed took 4½ hrs. from start to finish, but this time should be treated with caution, as they had a very enthusiastic operator. Another plate shown took 12 hrs. On a production basis, on the single-sided faceplates, which were more complicated to make, the times on an average were approximately 20 to 25 hrs. for both plates, complete and ready for the foundry. His shop had only been on a production basis since December, 1952.

Mr. Taft at this point had to bring the discussion to a close because of time. He recorded the branch's appreciation of Mr. Potts's paper, and expressed gratitude for all the work he had put into it. The information obtained was of great value to the industry he said.

LONDON BRANCH DISCUSSION

At the London branch meeting of British Foundrymen held in the Waldorf Hotel, Aldwych, Mr. Graham Bisset was in the chair and before proceeding with the business of the meeting he referred to the passing of Queen Mary and asked the members present to stand in silence for a few moments in tribute to and respect for a very great lady.

The chairman then went on to introduce Mr. D. H. Potts, the lecturer for the evening, who, he said, had been a member of the Brassfoundry Productivity Team which had visited America. The subject of matchplates was one in which he had taken a particular interest, and on which he had since spent a good deal of time in investigation. He understood the lecture was to be in two parts —the first dealt with experimental work in the foundry and was illustrated with slides. Then there would be a short discussion to be followed by further slides and examples of the more advanced work which had been done when a number of snags had been eliminated. Finally, the second section would form the subject of further discussion. Accompanying Mr. Potts was Mr. Hall, production engineer of the foundry who would answer any questions within his own province.

PART I

Mr. A. A. Matthews opening the discussion on the first part of the Paper asked what was the weight of the plate described.

Mr. Potts said he thought it might be about three pounds. He had not got the plate with him, but it was light enough for matchplate moulding by boys.

Mr. Winnett asked about the asbestos sheet separating the mould and metal container, and wanted to know if it was the same size as the bottom of the container or if a disc smaller than the container could be used?

Mr. Potts said it only covered the area of the receiver. They were now working with a receiver 6 in. dia. with a downgate of 2 in. dia., approximately, and the asbestos had to cover the receiver comfortably. The disc was about $\frac{1}{16}$ to $\frac{1}{8}$ in. thick, varying according to the casting and the weight of metal to be placed on top of it.

Mr. Day asked what material was used for the frame.

Mr. Potts answered that the frame on the bottom half-mould was an ordinary mild steel frame. In America, one firm used a steel frame while another firm used a steel frame inside which an asbestos strip was pinned. This strip went all the way round and was slightly deeper than the frame itself.

Parting Agents

Mr. J. G. Bailes who had also visited the American firms making matchplates, had noted it had been found necessary to use a silicone release agent to make the joint, because nothing else was good enough. It would appear that the Westinghouse Company's foundrymen had something better and cheaper. Did the Author think that was so? Secondly, he would point out that they had found out something elementary, and yet the Americans had not found it, and that was by using a 4-in. nail and applying air pressure behind, they obtained a perfect release of the pattern. He congratulated Mr. Potts for finding two little points which were very good.

Mr. Potts said as to silicone release agents, he had to confess to complete ignorance. In America, they visited two firms only who were operating the plaster casting process, and they were with those firms a matter of 2 or 3 hrs. only. The parting agent, they were told, was an insoluble oil. He had started off using machine oil and then had consulted the laboratory staff who suggested:—petroleum jelly, 1 part by weight, and kerosene, two parts by weight; this gave good results. Another mixture tried was, 6 oz. stearic acid, 3 oz. kerosene hot and 1/10th oz. of Aerocol, a wetting agent,

Mr. Wizard asked what was the nature of the plaster used.

Mr. Potts, before replying, asked the chairman if he was allowed to use the firm's name? Having received permission, he went on to say that to his knowledge there was only one plaster suitable in this country and it was made by the Gotham Company, Limited, and marketed by the Harborough Construction Company, Limited, of Market Harborough, Leicestershire.

Mr. Rutherford asked whether there was any risk of the patternplate casting being spoiled by inclusions of asbestos arising from the puncturing of the asbestos diaphragm.

Mr. Potts said he did not think so. What happened when they applied the air pressure was that the disc broke very much as would a piece of paper when one poked one's finger through it. Occasionally there was a slight amount of the disc trapped in the metal, but this happened seldom.

Pouring Arrangements

MR. D. MORRIS asked, was it necessary to heat the air, warm the receiver, or to calculate the exact amount of metal.

MR. POTTS said they worked with a warm mould and receiver. Such practice imparted a better finish to the casting. Founders should make certain that there was enough metal, for, with insufficient, air would be entrapped and a porous casting would result.

MR. MORRIS presumed that, if there was a quantity of excess metal, it would be joined to the pattern.

MR. POTTS said if they had metal left in the receiver, and he advocated this, they dug out part of the plaster top mould. The receiver was also lined with the same type of plaster as that used for the mould, and the bottom half of this lining was made separate from the top half so that it was quite simple to withdraw it from the receiver.

MR. A. R. PARKES asked if any wetting agent was used in mixing the plaster. Also, could Mr. Potts say if the aluminium was slushy, or would be slushy at normal pressures, and that the air pressure helped to make it sufficiently fluid to run properly.

MR. POTTS, in his reply, suggested that the plaster should be used as supplied by the British plaster industry and mixed as recommended. He knew nothing about plaster and all he could say was that the plaster as purchased did the job. The metal was at 610 deg. C. and was approaching the slushy state, but it had not quite got there. The air pressure was not used because the metal might be slushy, but to drive out any moisture vapour in the mould away from the face and to pack the metal into it and to impart the required finish.

MR. RODRIGUEZ asked, could an ordinary foot pump be used instead of pressure air line.

MR. POTTS agreed it could; what was needed was merely 6 to 8 lb. per sq. in. pressure and the ability to hold it until the metal had solidified. If they connected up an air pump with a small receiver coupled to the metal receiver, he thought it would be satisfactory.

Alloy Base

MR. MOCHRIE asked why Mr. Potts had mentioned L.S.2 aluminium alloy.

MR. POTTS said he meant aluminium alloy L.33—L.M.6. In that connection he wondered himself whether he was using the best type of alloy. The Americans were using an alloy similar to our DTD.424, of which complete details were not available, but he thought a better finish might result here with DTD.424, but he had not yet tried it out on a production basis.

MR. HARVEY asked, had there been any trouble with sinking where thick sections were surrounded by thinner sections.

MR. POTTS replied that the usual types of sinking were encountered. They overcame the trouble in two ways: (1) the section could be lightened out with a sand core—as had been shown—or (2) it could be lightened out with a plaster core, when making single-side plates. If that were insufficient, aluminium denseners could be inserted into the plaster and the cooling rate equalized. The denseners themselves were made by the same method, *i.e.*, the plaster casting process. Dealing with a supplementary question on the denseners, Mr. Potts said they were not treated in any way, but an essential precaution was to see that they were dry.

Baking Details

MR. J. P. P. JONES asked if, when Mr. Potts said that the plaster mould was stoved at 400 deg., he meant Fahrenheit or Centigrade and was the plaster mould taken straight up to 400 deg. or was this done by easy stages over a period of time.

MR. POTTS replied the temperature was 400 deg. F., and he did not know whether the mould was put into an oven at 400 deg. or taken to that temperature by easy stages as this was in the hands of another executive. (Mr. Logan commented on this point at a later stage.)

MR. HARVEY, on the same subject, asked if, when the pattern was put into the oven, it was heated direct to 400 deg. F., or thereabouts, or was it taken up to that temperature in stages.

MR. POTTS said the pattern he had shown was dried in an ordinary large mould-drying oven. He suggested the temperature should be brought up gradually, that is at 200 deg. F. to start with for two or three hours and then it should be taken up to 450 deg. F., and held there for approximately 12 hrs. Having dried the mould, it should be used as soon as possible and not be left lying about because the plaster would absorb moisture again.

MR. DAYBELL asked whether the plaster was thoroughly dry—right through—after 12 hrs.

MR. POTTS said a number of moulds broken up after casting they had found to be still damp, but the moisture was driven away from the casting face to a depth of at least 1½ in.

MR. DAYBELL further asked had gas holes been found just under the skin in any of the castings.

MR. POTTS said " Sometimes, after all, they were but foundrymen! " There was a tendency for the metal, while holding it in the liquid state for 15 to 20 minutes, to become a little crystalline, but the fact of the added air pressure gave a much better definition than when using a sand mould. One of the single-face plates exhibited was formed from a mahogany master pattern which had received two good coats of water-proof, clear varnish, and yet the wood graining was picked up by the casting.

Referring to the gas holes, MR. BAILES said he had seen many matchplates in America for which the mould had not been dried for 12 hrs. Four hours was nearer the time and any holes there might be were just soldered up.

MR. POTTS said he had brought some matchplates which he would pass round after the talk.

PART II

THE BRANCH PRESIDENT, opening the questions on the second portion of the lecture, said the lecture

Pressure-cast Pattern Equipment

was one of the most enjoyable he had ever listened to.

MR. TALBOT asked if it was necessary to treat the plaster mould in any way to improve the finish of the casting or did they depend entirely on the plaster surface itself for the finish on the master pattern.

MR. POTTS said the finish on the casting depended entirely on the quality of the master pattern. There was no finishing agent and nothing was added to the plaster mould. Metal was cast directly into the plaster mould and without any dressing.

Renewable Sleeves

MR. RUTHERFORD questioned the use of a plaster lining for the metal receiver; presumably this would be damaged each time a casting was made. Could not this trouble be avoided by using a fresh lining of asbestos paper for each casting.

MR. POTTS said they had worked with plaster. He had seen the process in operation by two firms in America and one used a receiver lined with plaster and the other was working with an asbestos sheet lining, but he considered the firm using the plaster sleeve were the better firm and they had followed their example. The plaster sleeve was in two parts, the bottom 6-in. portion, being detachable, could be taken out after each cast and a new one put in so that it was not necessary to re-line the whole of the receiver each time.

MR. MATTHEWS asked what time lag there was between the metal entering the receiver and its transfer to the mould. Seeing that the metal was poured at 610 deg. C., what would be the temperature of the metal when it entered the mould.

MR. POTTS replied that if Mr. Matthews had the impression that he would have to be very quick in putting the cover on the receiver after the metal had been put into it, he was mistaken, because the metal would remain molten for at least 10 to 15 min. in the mould itself. He calculated that, before turning on the air, the metal was in the receiver about six seconds.

Mould Assembly

MR. HARVEY said he noticed on the plate two dowels; were they used as a location when making a pair of matchplates.

MR. POTTS explained that the patternplate with pins in was a single-side plate only, and two plates were required to make a complete mould. To pick up the dowelling system for the moulding box, they initially used a machined plate on which were two loose dowells. On those dowels they slipped little bushes, which were then cast into the plaster mould. Into these bushes, subsequently, pegs were placed, which were cast into the plate.

After casting a frame, a drilling jig was used to pick up the moulding-box pin-centres. In this frame, there were two holes for locating the dowel pins, one of which was elongated by $\frac{1}{32}$ in., and two bushed holes corresponding to the pin-centres of the moulding boxes. The frame was slipped over the two dowel pins, and the plate was drilled, using the bushed holes as a drilling guide.

MR. DAY asked if the L 33 alloy was treated in the normal way, before casting, and, secondly, he had received the impression that in the mould as assembled for casting there were two half plaster moulds between which there was a steel frame and on the top of that there was a metal plate and then the metal receiver above the whole. The asbestos disc came on top of the plaster and he assumed it was fitted into the plate. How was the whole held together.

MR. POTTS re-showed his slide of the assembled mould to demonstrate the position of the asbestos sheet and said a depression was cut in the plaster, when it was in the semi-solid state, to accommodate the asbestos sheet.

In reply to the other part of Mr. Hall's query, Mr. Potts said they treated the metal in exactly the same way as when producing pressure-tight production castings.

Plaster Characteristics

MR. LOGAN said drying was indeed very important, and the temperature as given by the lecturer, 400 to 420 deg. F., should not be exceeded. He would in fact suggest that the temperature should be kept to 400 deg. F. That was rather important because of the necessity to control the shrinkage. For the sake of accuracy of record, the plaster was a high-grade, high-strength autoclave plaster based on gypsum, and considerable research had been carried on to develop it. This research was still proceeding and he did not think it could be regarded as having reached finality, particularly as regards shrinkage characteristics. In this connection it was desirable to keep drying conditions identical for each half mould—so that the two halves would really match when dried. If one half plaster mould was heated too suddenly, or too quickly to a high temperature, it might shrink away from one end of the moulding box in such a manner that the two halves would not match closely. If the halves were dried carefully together, and slowly in the initial stages, that trouble would not arise.

His other point concerned the metal casting temperature; there again he could confirm what the Author had said. It had to be remembered that plaster was an insulating material, and metal poured into a plaster mould took a long time to solidify. If the casting temperature of 610 deg. C. was exceeded, all sorts of extraordinary troubles would occur. These could be avoided by maintaining a low casting temperature, and, as the lecturer had indicated, by lightening out the thicker sections with cores where necessary in the pattern castings themselves.

MR. RODRIGUEZ asked if the method had been tried out in part only, *viz.*, with a good green-sand mould.

MR. POTTS said it might have been done, but his firm had not made the experiment.

MR. FEATHERSTONE asked were the men engaged on the work moulders or patternmakers?

MR. POTTS said the men engaged on the actual making of the plaster moulds were patternmakers, whom they termed metal patternmakers.

Mr. Wizard said he was not clear as to why it was necessary to have the low pressure of 6 lb. per sq. in. on top of the metal in the container. Why would it not feed by gravity; there was quite a large mass of metal there.

Mr. Potts said they started off by using ordinary gravity running but did not get the good definition that was possible by using pressures of 6 to 8 lb. per sq. in. Increasing the pressure had shown that if they went too high it began to buckle the plaster mould.

Degree of Skill Required

Mr. Harvey asked if there was any trouble with contraction in the centre of the plate. Was it found that the frame more or less held the metal in the four corners and the centre broke away from the frame. Were the men engaged on that business in America patternmakers or were they semi-skilled only. In the Brassfoundry Report there appeared to be illustrated a large machine for holding the boxes together, or at least some solid support. What was the reason for that: were the Americans casting at a higher pressure than here.

Answering these points Mr. Potts said in America that process had been going on since 1934 or 1935 and had developed considerably. Firms were now complete specialists in the process and handled patternmaking solely by that process. They appeared to have captured a fairly big market and their patternplates went from one to six feet in dimensions. The pressures used were from 3 to 8 lb. per sq. in. In America he did not know what grade was employed, whether skilled or semi-skilled patternmakers. Regarding contraction around the outside of the frame, no trouble had been experienced on the outside edge of the plate itself, but occasionally shrinkage trouble had developed in the centre of the plate, when casting a large pattern. This could be overcome by lightening out with a core or with denseners. In the firm's limited experience they had not run into any insuperable difficulty in connection with contraction.

Arrangement for Optimum Feeding

Mr. Kilby asked if it was possible, on certain patterns, to so use the receiver that one got the feed over the heavy section, as was normally done in sand moulding to save shrinkage in the heavy section.

Mr. Potts said, with their experimental casting machine, the receiver was fitted to the running system of the plate itself.

Mr. Kilby said he was thinking of a pattern, say, of a wheel eight or nine inches in diameter with a fairly heavy centre boss.

Mr. Potts said he saw no reason why they should not run over the boss, but it would mean that the casting unit would have to be altered each time to do this.

Mr. Kilby said that brought him to another point he wished to make. He was experimenting himself and was afraid he had not had the success he had been led to believe was possible. For the actual time taken in producing such moulds, he thought the time lags had not been taken into account—there was delay in mixing the plaster, filling the mould and waiting for it to set. It was a satisfactory process if there was a long run of moulds, but with one or two only it became a very expensive job. In his experiments he had followed exactly the way described, but it took him two days to make one mould, or two and a half days making two moulds. They were now in the core stove and had been there for two or three days. He hoped to take them out and try them, but up to date he had spent almost three and a half days on those two moulds.

Mr. Potts said he was sorry Mr. Kilby had been disappointed initially and suggested he would not get results the first time. His firm had started two years ago, and had actually waited nine months until he could get one man relieved of other duties, who had carried out the experimental work. Having tried out the system, they would not get really good results until the operators had been trained to handle the materials.

Mr. Kilby said the reason he had raised the point was that they had been told the plate took four hours to make, but the master pattern might take twenty hours or more, and if only one plate was required, it would cost much more than the members would expect.

Mr. Potts said he had given a warning that the times quoted should be treated with some reservation. The man engaged by his firm was tremendously interested and was one of those who liked to work at piece-work speed. The actual times he was employed on those moulds were accurate, but he was doing a series of plates and while waiting for one mould to set, was making a second.

Corroborative Evidence

Mr. Levy said, as no doubt many members were aware, a specific purpose of his visit to the United States a year or so ago was to investigate the possibilities of pressure-cast patternplates, and he had seen the whole process. The question of time was most important. He also emphasized the quality of the plaster. In the States they had a natural gypsum, and he had been informed on good authority that, definitely, there was admixture of asbestos used with it. It might be that British plaster was all the better for not having asbestos in it, and he had to admit that Mr. Potts's plates (exhibited) were very much superior in finish to a good many that he had seen in America, and particularly as far as the large-size plates were concerned.

On the whole, he thought plaster casting of patternplates should not be rushed; a little discretion and experimental work on the part of the individuals would get its reward. The pressure used by the Americans was generally not much more than three to five pounds, lower even than that Mr. Potts was using, and from the size of the asbestos baffle (used in the bottom of the container) he would say that the higher pressure was due to the greater thickness of the sheet employed here.

The Branch President (Mr. D. Graham Bisset) said it was necessary to keep a sense of proportion; neither Mr. Potts nor anyone else would ask

Pressure-cast Pattern Equipment

a foundryman to make a patternplate for a "one-off" casting. Mr. Potts was thinking of production plates which required quality and accuracy with most present-day methods of moulding, and he thought the process should be viewed from that angle. Members should not confuse the one- or two-off job with perhaps 500 or 1,000 off, which were quite a different matter.

MR. MOORE asked, when blowing the pattern out of the plaster, if any kind of a pressure fitting or nozzle was used.

MR. POTTS said they had a nozzle fitted to the end of the air line sufficiently small to go into the hole that the nail had formed. It was just an ordinary brass cock drawn out to the size of the hole. They pushed it down and turned on the air and the pattern was released.

Production Times

MR. HARVEY confirmed Mr. Potts's times of manufacture, especially on jobs where there was a rather large pattern on a small plate, say 12 by 12 in. or 14 by 12. His times were, in his opinion, in the right region of about 6 hrs. for making the plate.

MR. PIERCE said he had been amazed by the times given for making such plates. He had seen and had been personally responsible for some very intricate matchplates and had seen them made very quickly, but he could not reconcile the making of the job shown in 8 hrs., where they had to make the pattern also of plaster. He wondered if a mistake had been made, and the speaker really meant to include the time for making the pattern as well as the metal patternplate.

MR. POTTS said with regard to times, he might have misled members slightly. The centre plate on the slide shown* had six individual aluminium patterns mounted on a cast-iron plate. The time given of 4 hrs. was for making those individual patterns only. All the other times quoted were from receipt of the master patterns to delivery of the completed plate to the foundry, excluding stoving time.

Appreciation

MR. BAILES thought there was a general inference from the paper which was of some interest. As a nation we were noted for our skill in under-statement. In the lecture members had been told of something good which had been picked up from abroad but, what was of more importance, the good idea had been accepted, used, and improved upon. Mr. Potts was to be highly congratulated on the excellent development work he had put in.

MR. LEVY, in proposing a vote of thanks, said he was in a somewhat unique position to appreciate the enormous amount of work that Mr. Potts must have put in, not only in the production of his plates, but in the presentation of the Paper in a lucid manner. Having seen the kind of patternplates that the Americans were turning out and compared them with the high-quality plates that Mr. Potts had produced, it was evident that he had made some advances on the American system, and he presumed that those advances were a combined effort—resulting from the skill of his operatives and the excellence of materials and the methods which had been employed.

Essentially, the whole system was much the same as that which he had seen operating in the States, but in practice—and, as practical men, that was members' chief interest—Mr. Potts's results were infinitely better. If any members were considering trying the system out, he would say, "Don't try to run before you can crawl." Apart from that he could only thank Mr. Potts for his efforts and for the exceedingly interesting paper.

MR. WIZARD, seconding, said a great number of points came to mind when speaking of matchplates, but there had been an excellent discussion, and what they had been told was quite simple, direct and extremely clear. The only thing that some members were puzzled about was whether they could make matchplates. It usually took eight or nine hours, and they were never very satisfactory. Those founders who had not got air pressure available might investigate a little further to see if it could be done by gravity casting. He thought the London branch were to be congratulated on securing such an excellent and practical Paper. There was one thing he had not heard mentioned, and it concerned the handling of plaster. There was a snag that, if plaster was mixed too much and overworked, it became useless.

The vote of thanks was carried by a hearty round of applause.

* JOURNAL July 31, 1952, p. 124, Fig. 21.

Plate-lifting Clamp

The plate-lifting clamp shown above is made by Chamberlain Industries, Limited, Staffa Works, Leyton, London, E.10, and appears to be useful for foundries handling plate castings, though the description accompanying the illustration refers to steel plates. It is made in two sizes, the smaller of which will carry a ton.

Survey of the Shell-moulding Method of Casting Production*

By Bernard N. Ames

(Continued from page 59)

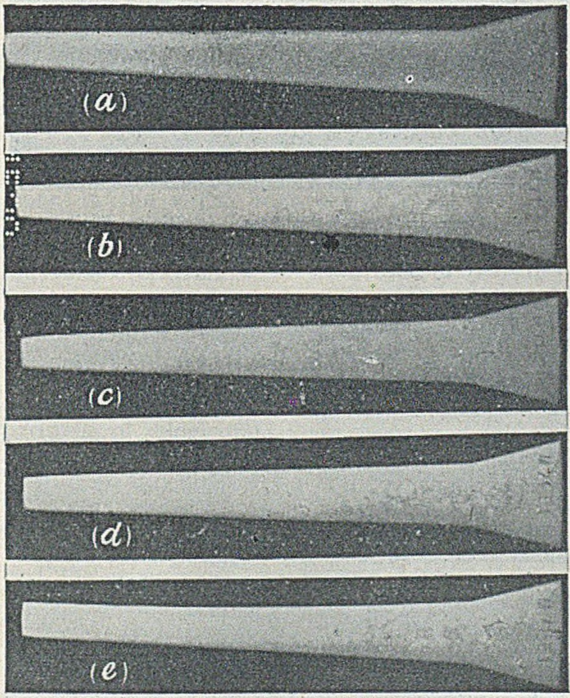
Effect of Shell Thickness

To investigate the effect of shell thickness, wedge moulds were prepared in thicknesses of 1/16 in., 1/8 in., 1/4 in. and 5/16 in. Two moulds of each thickness were clamped and bedded in medium steel shot, with 2½ in. of backing. These were cast from a 5 per cent. silicon/aluminium alloy at 1,250 deg. F., (675) in gunmetal bronze at 2,050 deg. F., (1,120) grey iron at 2,720 deg. F., (1,510) and Navy class " B " steel at 2,950 deg. F. (1,620 deg. C.). Two green-sand control plates were cast with each series. As in the back-up test series, 1/8 in. thin slices were taken from the wedges, longitudinally, at 2 in. from the side opposite the gate for X-ray inspection while the adjacent slices were macroetched, in the case of gunmetal bronze and aluminium-alloy specimens.

No appreciable differences in soundness between castings of varying shell-mould thickness were found on examination of the aluminium macros and radiographs although the mean grain size of the sand-cast control was slightly smaller. Radiographs of the bronze specimens, Fig. 26, did not indicate any appreciable sensitivity to shell thickness from the standpoint of internal unsoundness. The macrographs as shown in Fig. 27 showed the skin chill condition on the green-sand control and the usual lack of skin chill in the shell-mould castings. A definite trend toward larger grain size as the thickness of the shell is increased can be noted. This is indicative again of the insulating effect of shell moulds.

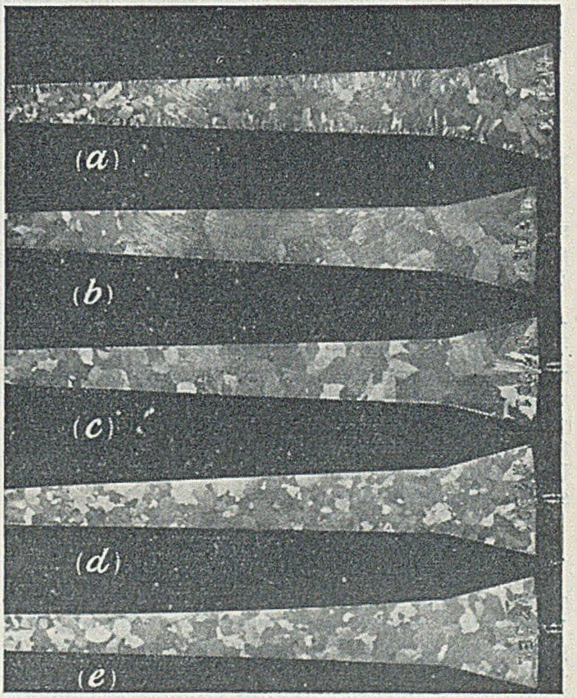
The shell-cast grey-iron slices exhibited light

* Official Exchange Paper from the American Foundrymen's Society presented to the Annual Conference of the Institute of British Foundrymen and published with permission of the U.S. Navy Department. The Author is supervising physical metallurgist, Material Laboratory, New York Naval Shipyard. The opinions or assertions contained herein are those of the Author, and are not to be construed as official, or necessarily reflecting the views of the Navy Department.



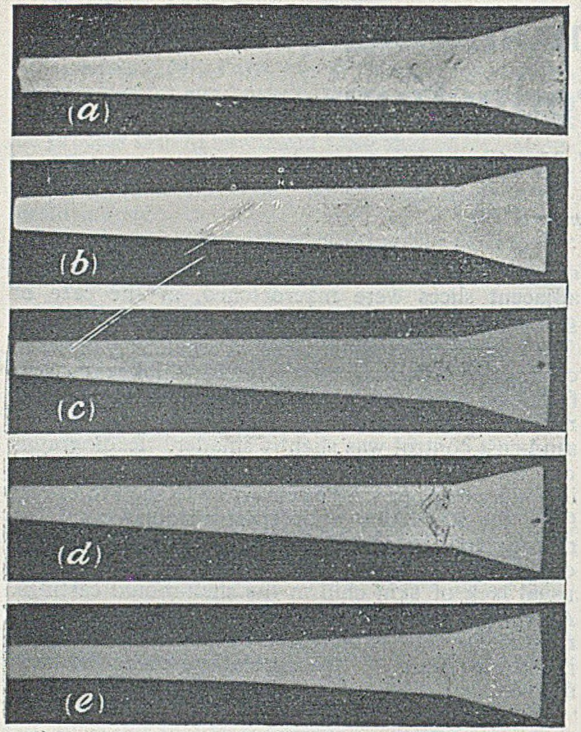
(a) Control; (b) 5/16-in. Shell; (c) 1/4-in. Shell; (d) 1/8-in. Shell; (e) 1/16-iu Shell.

FIG. 26 --*X-ray Photographs of Thin Slices to show the Effect of varying Shell Thickness on the Soundness of Shell-cast " G " Bronze Test Plates.*



(a) Control; (b) 5/16-in. Shell; (c) 1/4-in. Shell; (d) 1/8-in. Shell; (e) 1/16-in Shell.

FIG. 27.—*Effect of varying Mould Thickness on the Macrostructure of Shell-cast " G " Bronze Test Plates.*



(*a*) Control: (*b*) 5/16-in. Shell; (*c*) 1/4-in. Shell; (*d*) 1/8-in. Shell; (*e*) 1/16-in Shell.

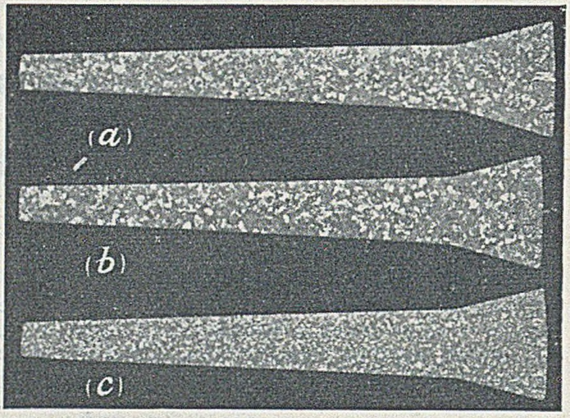
FIG. 28.—*X-ray Photographs of Thin Slices to show the Effect of varying Shell Thickness on the Soundness of Shell-cast Class "B" Steel Test Plates.*

shrinkage at the sinkhead wedge junction, with a slightly heavier shrinkage condition on the 1/8 in. and 1/16-in. shell slices than on the two heavier shell specimens. The controls showed least shrinkage, possibly due to a slight gas porosity condition, but had rougher surfaces.

Overall X-ray radiography on the steel wedge plates demonstrated that the green-sand controls were inferior from the standpoint of surface finish, although all castings possessed a certain amount of shrinkage due to gating design. Thin slice radiographs, Fig. 28, showed the shrinkage in the casting to be slightly less extensive in the 1/16-in. shell with little difference in gas porosity between any of the shells and green-sand control.

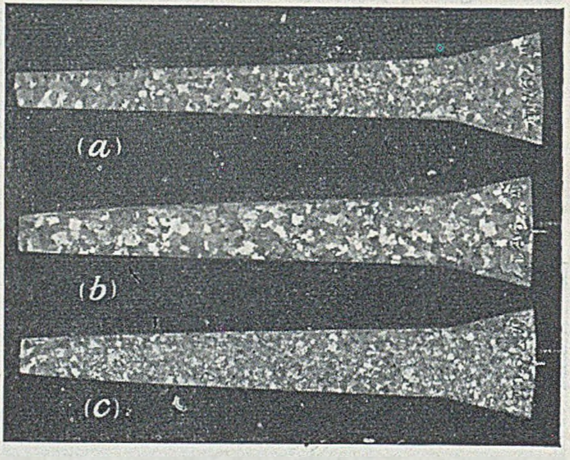
Effect of Curing Time

To investigate the effect of this variable on macrostructure and internal unsoundness, a number of wedge-plate moulds were made following standard procedures, except that curing time at 600 deg. F. (310 deg. C.) was varied from 1/2 min. to 2 1/2 min. Two moulds in each cure-time group were clamped, bedded in 2 1/2 in. of steel shot, and poured in gun metal bronze at 2,050 deg. F., (1,120 deg. C.) together with two green-sand control plates. The castings were sectioned in the usual manner, a 1/8-in. slice being taken 2 in. from the end opposite the



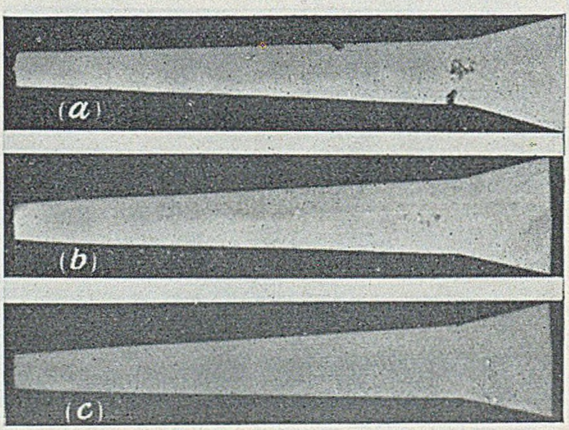
(*a*) Green-sand; (*b*) Silica Shell; (*c*) Zircon Shell.

FIG. 29.—*Effect of varying Base Sand on the Macrostructure of Shell-cast Al-alloy (No. 43) Test Plates.*



(*a*) Green-sand; (*b*) Silica Shell; (*c*) Zircon Shell.

FIG. 30.—*Effect of varying Base Sand on the Macrostructure of Shell-cast "G" Bronze Test Plates.*



(*a*) Green-sand; (*b*) Silica Shell; (*c*) Zircon Shell.

FIG. 31.—*X-ray Photographs of Thin Slices to show the Effect of varying Base Sand on the Soundness of Grey-iron Test Plates.*

gate, with the adjoining slice etched for macro-examination. No significant differences in the degree of internal unsoundness were noted in either the macrostructure or radiographs.

Effect of Base Sand

To determine the effect of a substitute sand grain such as zircon sand (a considerably denser material of higher heat conductivity), a number of ½-in. shell wedge moulds were prepared. One set contained a normal silica sand mix; the other a fine (about 140 A.F.S.) zircon sand, in the proper proportion (4.5 per cent. by weight) to maintain the normal sand-to-resin volume relationship. Eight moulds of each type were clamped, and bedded in steel shot, 2½ in. all round, together with eight green-sand control plate moulds. Two of each were cast in a 5 per cent. silicon-aluminium alloy at 1,250 deg. F. (675 deg. C.) gunmetal bronze at 2,050 deg. F. (1,120 deg. C.) grey iron at 2,740 deg. F. (1,505 deg. C.) and class "B" steel at 2,950 deg. F. (1,620 deg. C.). Macro and thin slice X-ray specimens were taken in the usual way.

The photomacrographs of the aluminium slices, Fig. 29, showed a finer grain-size in the zircon-cast specimen, indicative of a more rapid rate of solidification. Positive prints of radiographs of thin slices showed equivalent microporosity in green-sand and silica-shell cast slices, with somewhat less microporosity in the zircon specimen. Overall X-ray radiography on the aluminium wedge plates confirmed this condition.

In the bronze plates, a finer grain-size was evidenced by the specimens cast in a zircon shell as compared with those cast in green-sand or silica shells (Fig. 30). Radiographs of the grey iron specimens showed an area of shrinkage at the sinkhead-plate junction of the sand-cast plate, with less shrinkage in the silica shell specimen and practically none in the zircon shell slices (Fig. 31). The exographs of the class "B" steel slices cast in silica and zircon shell moulds did not exhibit any appreciable differences.

Comparison of Mechanical Properties

Duplicate heats were run to determine the optimum pouring temperature for shell-cast 5 per cent. silicon-aluminium alloys and to secure comparisons of elongations and ultimate strengths between shell-cast and green-sand bars at various pouring temperatures. For these heats, the as-cast 0.505 in. double tensile bar design was used as shown in Fig. 32, the plastic-bonded shells being moulded with a 10 by 12 in. plate and pattern, and the green-sand counterparts being made in No. 0 naturally-bonded Albany sand with a wood pattern of similar design and dimensions. In each heat, two shell moulds and two green-sand moulded tensile coupons, were poured off at each of the following pouring temperatures—1,350, 1,300, 1,250 and 1,200 deg. F. (730, 700, 680 and 650 deg. C.). In addition, two shell-mould wedge plates and two green-sand control plates were poured off at each temperature. All shell moulds were bedded with a 2 in. thickness of steel shot.

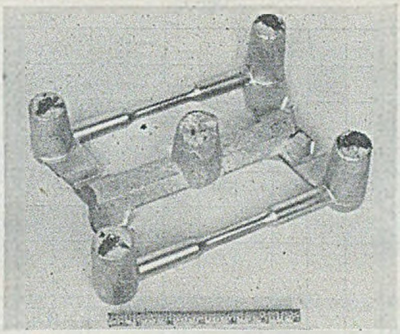


FIG. 32.—*Shell-moulded Aluminium-alloy Test-bar (43 Alloy), As-cast.*

The graphed results are shown in Fig. 33. It was observed that at the higher and optimum pouring temperatures, the overall properties were slightly superior for the shell-cast specimens. Radiographs of thin slices taken from the wedge specimens indicated a tendency for a greater degree of internal soundness in the shell-cast specimens. It is believed that the superior properties of shell-cast bars at the temperatures noted are due to the improved cleanliness exhibited in the fractures of the tensile bars.

For similarly testing the tin-bronze tensile bars, the pattern equipment used was a double bottom-gated test-coupon pattern mounted on a 14 by 18 in. plate (Fig. 6) for shell moulding and a wooden counterpart mounted on a follow-board for green-sand moulding. Two types of tensile bar inserts were used for each pattern, one a pair of bars

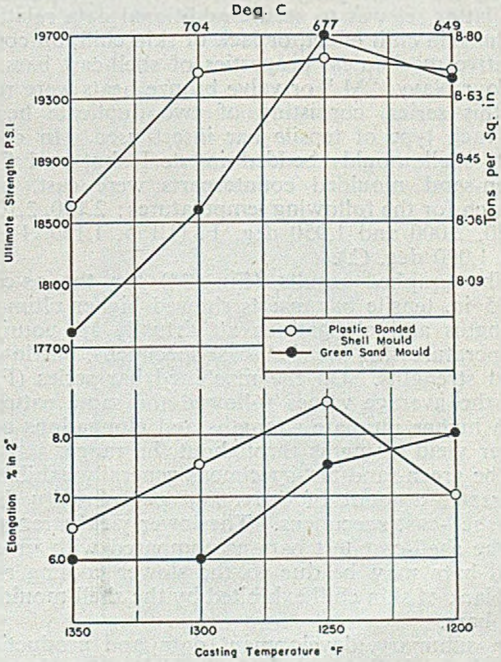


FIG. 33.—*Mechanical Properties v. Pouring Temperature of Aluminium-alloy Shell-cast and Green-sand-cast Tensile Bars.*

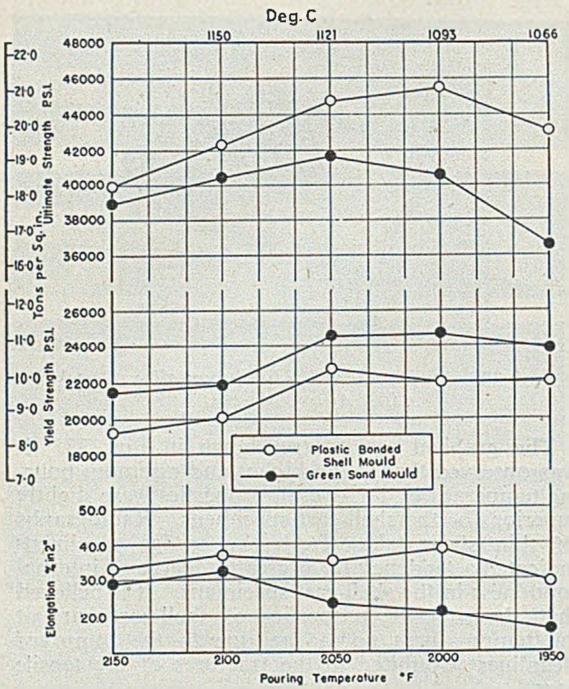


FIG. 34.—*Mechanical Properties* v. *Pouring Temperature of Navy "M" Bronze, As-cast Gauge Shell and Green-sand-cast Tensile Bars.*

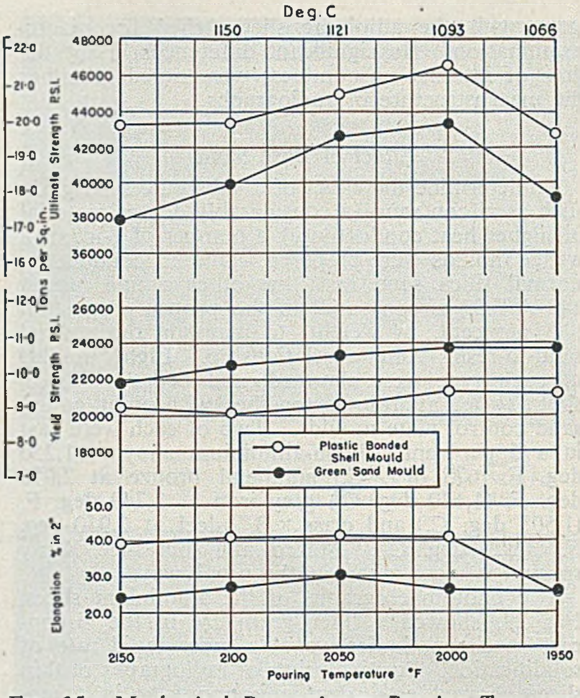


FIG. 35.—*Mechanical Properties* v. *Pouring Temperature, for Navy "M" Bronze, Machined Gauge Shell and Green-sand-cast Tensile Bars.*

of standard oversize gauge diameter requiring machining to finish to 0.505 in. gauge diameter, and the second pair calculated to cast to approximately 0.505 in. gauge diameter. The purpose of this latter set was to secure additional data relative to the skin chill effect, or lack of skin chill, on comparative mechanical properties of shell-cast bars.

Four Navy " M " or valve bronze heats were run in this series, consisting of two duplicate heats for each type of tensile bar insert used. In each heat, shell moulds bedded in steel shot and five green-sand moulded counterparts were cast, one of each for the following temperatures: 2,150, 2,100, 2,050, 2,000 and 1,950 deg. F. (1,175, 1,150, 1,120 and 1,090 deg. C.).

The graphed results (Fig. 34) for the as-cast 0.505 in. tensile bar inserts showed higher ultimate strengths and elongations at virtually all pouring temperatures for the shell-cast specimens, but lower yield strengths. On the machined bar series (Fig. 35) the average values followed the same pattern, with higher ultimate strengths and elongations and lower yield strengths throughout the range.

The green-sand test-specimens generally exhibited a greater amount of dross and gas porosity than the shell-cast specimens. The lower yield strengths of the shell-cast test bars as compared with green-sand bars may be due to the slower cooling rate and lack of skin chill exhibited by the shell-moulded test bars.

In summary, development data and production experience indicate that shell-moulded castings in the ferrous and non-ferrous alloys can develop mechanical properties and internal soundness, at least equal to, if not superior to, green-sand castings. The trend toward greater internal soundness and high mechanical properties in the shell-moulded castings can be attributed to cleaner metal with less gas inclusions and dross. This is probably a function of a consistently clean mould with good permeability and venting capacity.

APPLICATIONS AND ECONOMICS

The shell-moulding process is currently being utilized on a variety of parts predominantly in the ferrous alloys (grey, malleable and spheroidal iron). The applications which may be suitable are closely related to the economics of the process as compared with conventional practice. From an overall point of view every casting design is not suited for the shell-moulding process. Tooling costs are still relatively high, and hence, the necessary volume is a basic requirement. Secondly, the design of the casting must lend itself to a suitable parting and gating arrangement. Thirdly, and possibly the most important factor, will be the degree of saving that can be effected in the cleaning room and machine shop since the greatest economies will generally be effected in these departments. No general rule for a cost comparison with sand castings can be derived. Each casting must be examined on its own merits. Other considerations, however, which may be factors in considering the utilization of the shell process as a production technique, involve the conservation of material normally removed during machining operations or in parts produced in an alloy that is difficult to machine or in a significant decrease in foundry rejections. In the first case, if a large amount of material be removed in machining, or in the second case if machining costs be high, it may be advisable to consider shell moulding as an alternative and possibly more economical method of manufacture.

At the present stage of development, shell moulding is particularly suited to the production of castings in aluminium alloys, certain bronzes and brasses, high conductivity copper, malleable, grey and ductile iron and stainless steels. In the production of medium carbon steels careful control of investment formulations and processing and in the proper conditioning of the molten metal are necessary if pinholing difficulties are to be avoided. In the case of small tin bronze or aluminium castings, as indicated previously, which have been "treed" as in the investment-casting process and poured vertically, some difficulty has been experienced in penetration and "burning in" on the castings in the lower part of the mould.

The following applications for shell-moulded castings being produced on a production basis have been reported:[28]

(*a*) Automotive castings in grey iron such as governor bodies and bushings for automatic drives, exhaust valves in alloy steel, camshafts, rocker arms and crankshafts.

(*b*) Agricultural castings such as rocker-arm brackets, pinion-bearing cages, crankshaft pulleys, exhaust-pipe flanges and brake drums.

(*c*) Valve bodies, bonnets and pipe fittings such as tees and L-s in stainless steel and bronze.

(*d*) Ordnance parts in magnesium, aluminium, ductile and malleable iron.

(*e*) High-conductivity copper castings.

In addition to the above many miscellaneous castings are currently being evaluated for aircraft or general machinery utilization. At the shipyard foundry with which the Author is associated many different applications have been explored in the laboratory and a production unit on a jobbing basis has been in operation for several years. The operation of this shell-moulding unit, previously illustrated, which has been operated on a very simple, manual basis, has established the fact that considerable economies can be derived by the utilization of this process on a jobbing basis, provided the proper casting application is selected. The determination of the feasibility of the process

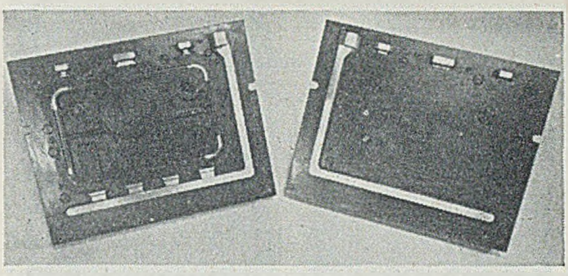


FIG. 37.—*Patternplates for a Mounting Panel, 14 by 18 in.*

on a particular casting design can be accomplished quite economically and quickly. A wooden dump-box or a hand-charging device, an oven which is capable of attaining a minimum temperature of 500 deg. F. (260 deg. C.) and an aluminium match plate or a steel plate with a rough mounted pattern is all that is required. On occasion to explore certain applications rough sand castings in bronze have been hand-tooled and mounted. This is illustrated in Fig. 36. On this impeller casting which was subsequently cast in several alloys to determine the practicability of manufacturing similar parts a slight backdraft condition existed on several vanes which were $\frac{1}{16}$ of an inch thick at the tip. However, suitable shells and castings in aluminium alloys and grey iron were obtained by this technique.

The first production shell-moulding job which was assumed by the New York Naval Shipyard centred around several fire-control instrument components in a 5 per cent. silicon/aluminium alloy. The original design specified sheet-metal fabrication but long-term delivery quotations necessitated a study of shell-moulding possibilities. Shell moulding as a manufacturing technique was finally decided upon due to the expected savings in the machining of gasket grooves of certain castings, superior surface finishes which were expected to reduce surface preparation for final painting and

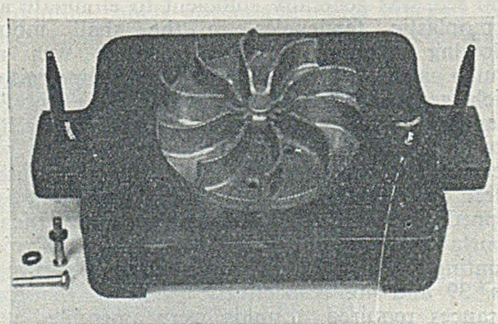


FIG. 36.—*Impeller Patternplate, 10 by 12 in.*

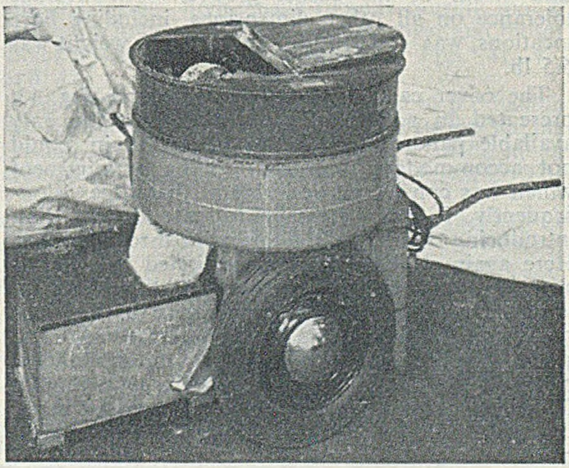


FIG. 38.—*Portable Muller for Resin/Sand Mixtures.*

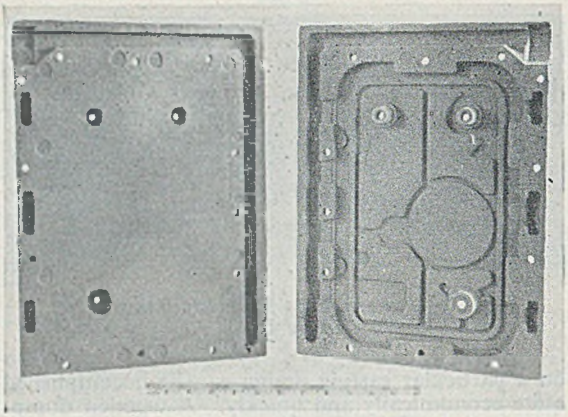


FIG. 39.—*Mounting Panel Mould, Cope and Drag.*

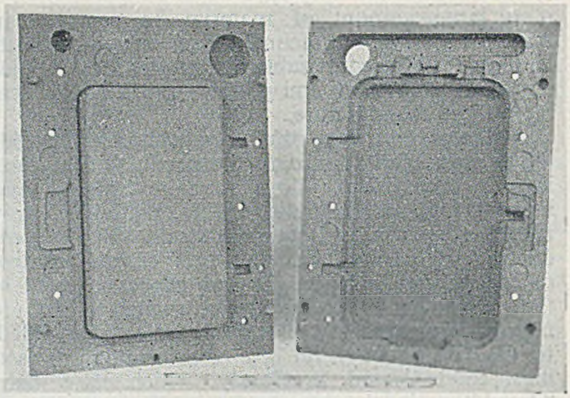


FIG. 40.—*Ordnance Cover Mould, Cope and Drag.*

the limited machine-tool facilities available at that time. Quantities for each item ranged from 1,300 to 4,000 pieces. The larger and more critical castings involved were:—(*a*) A cover casting; (*b*) a mounting panel, and (*c*) a motor mounting bracket. The plate equipment for the cover and mounting panel castings, was of alloy cast iron, while the patterns were of machined medium carbon steel, with aluminium runners in some instances. The plate and pattern for the motor bracket casting were of aluminium alloy throughout. All plates incorporated button-head, spring-return stripping pins for mould ejection and small tapered buttons, for bolting mould halves together.

The pattern equipment for the mounting panel casting is illustrated in Fig. 37. The pattern is bottom-gated, with three ingates, $1\frac{1}{2}$ times the area of the runner bar, while three small "risers" hold the top rim-section. A dry-sand pouring cup was set in a print at the top of the downgate. Metal shrinkage was provided on the pattern as in normal sand practice, *i.e.*, $\frac{3}{16}$ in. per ft. The maximum casting tolerance specified was $\pm$ 0.010 in. on a 13.75 in. length and 8.875 in. width of the casting, and $\pm$ 0.005 in. on the depth and width of the gasket groove. The average tolerance on all other dimensions, including bore locations, was $\pm$ 0.010 in. The pouring weight was 6.5 lb.

The cover casting, shown previously in Fig. 13, presented an additional problem in that the only available patternplate size 14 in. by 18 in. could not accommodate a bottom gating arrangement which was considered desirable at that time. Consequently, it was necessary to gate on the flat, introducing the metal through three ingates. Here again, lack of head necessitated the use of a pouring cup. Casting tolerances on this 12.500 in. long and 9.876 in. wide cover were of approximately the same order as the mounting panel. The poured weight was 6.6 lb. The motor bracket pattern, Fig. 7, was gang-gated, six to a mould. Difficulties in securing smooth surfaces on the lower castings on the "tree" with this gating arrangement necessitated a gating change. A print was located in the centre of the runner to receive a dry-sand pouring cup, and the mould was poured flat, without shot backing. The poured weight was 6 lb. On this casting, tolerances varied from $\pm$ 0.005 to $\pm$ 0.010 in. with no draft permitted on the motor mounting surface.

A portable muller mixer shown in Fig. 38, was utilized for mixing the resin/sand mixture. 150 A.F.S. silica sand of 5 screen distribution with 7 per cent. resin was generally used. The dwell and cure cycles were as follow:—

(*a*) *Covers:*

Dwell temperature range: 300 to 450 deg. F. (150 to 185 deg. C.) (a resin with wide setting latitude used).

Dwell time range: 10 to 15 sec. depending on plate temperature.

Cure temperature: 600 deg. F. (315 deg. C.).

Cure time: 50 to 60 sec. depending on plate temperature at dwell.

Average mould thickness: $\frac{3}{16}$ to $\frac{1}{4}$ in.

(*b*) *Motor Bracket Mounting Panel:*

Dwell temperature range: 370 to 450 deg. F. (180 to 185 deg. C.).

Dwell time range: 12 to 15 sec., depending on temperature.

Cure temperature: 600 deg. F. (315 deg. C.).

Cure time: 60 sec.

Average mould thickness: $\frac{3}{16}$ to $\frac{1}{4}$ in.

After the shell mould was stripped free, it was placed face down on levelling boards, and weighted with bags of shot to minimize distortion or handling deformation while hot. An elapsed time of 30 to 60 sec. was generally sufficient to eliminate any thermoplastic tendencies in the shell mould. Following stripping, the patternplate was run through as many cycles as the heat head permitted, which generally averaged three to five moulds, depending on the resins employed. When one half pattern had cooled past the usable range, it was placed in the oven for reheating, and the other pattern half used until that too required reheating. Stripped and cooled shells were stored vertically in portable racks until ready for assembly. Typical mounting panel and cover moulds are shown in Figs. 39 and 40, respectively. Due to the close tolerances required, moulds were assembled with machine screws and speed nuts, Fig. 14; driven with a torque-controlled electric nut runner. This

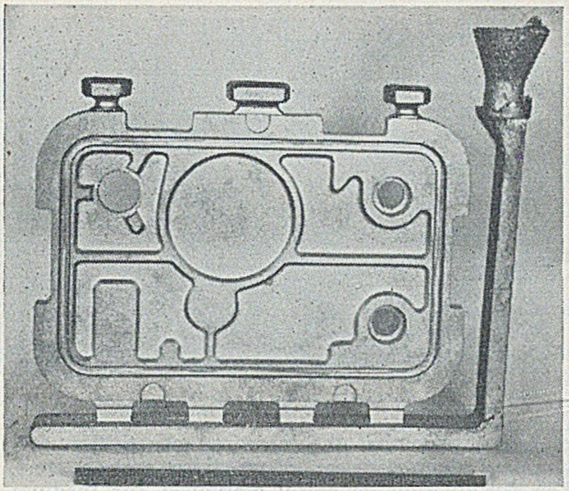


FIG. 41.—*Mounting Panel (approx. 12 by 9½ in.) As-cast.*

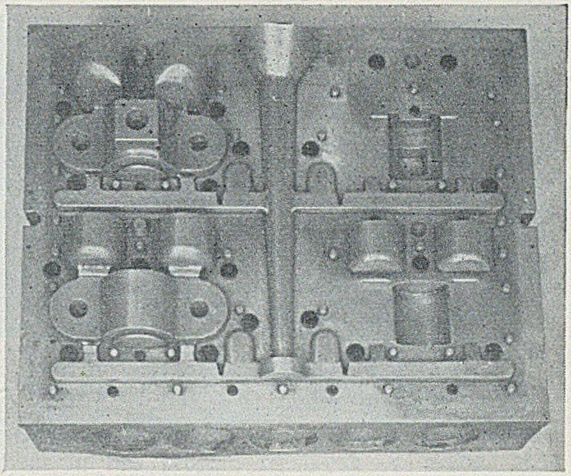


FIG. 43.—*Staging Clamp Patternplate.*

manner of assembly while holding dimensional tolerances and reproducibility to the most favourable degree, is time consuming and expensive. Before assembly, moulds were given a routine inspection for quality. Few defects were encountered. However, the defective moulds encountered usually were rejected due to thin spots, chipping or porous areas on vertical surfaces. The use of a quick-setting core paste, applied by bulb in a thin bead around the mould cavities, reduced assembly time appreciably, and promoted a strong joint. However, the application required extreme care; the paste, if placed any closer to the mould cavities than ½ in. resulted in casting blows. In addition, the bond line thickness generally influenced the casting dimensions.

For bedding, the mounting panels were placed vertically in the double compartment bedding boxes, three to each compartment, and a No. 660 steel shot valved into, around, and over the moulds, with a hose arrangement leading from the loading tank. Dry-sand pouring cups were dropped into the downgate print to provide a suitable head. The cover moulds were bedded in on the flat in a similar manner with a dry-sand pouring cup attached, save that only one mould per box could be bedded. The motor brackets were poured-off without shot backing since the light sections made additional mould support unnecessary.

Mounting panels, covers and motor brackets were poured from 1,350 deg. F. (730 deg. C.) or lower, three to a ladle. The pouring was done as close to the cup as possible, to minimize drop, and it was found necessary to control pouring temperatures very closely in order to minimize shrinkage. The moulds collapsed readily on breakout, displaying carbonization in the mould section area immediately at and bordering the casting cavity, with the remaining portions apparently unaffected. In all instances, castings broke out cleanly, with no adhering sand. No sandblasting or other surface cleaning was required at any time. Finning was practically nonexistent.

Dimensional tolerances in all critical areas were held satisfactorily. Control castings from each heat were radiographed and found to be free from objectionable internal shrinkage and gas porosity. Rejects in the mounting panel casting were fairly low, actually 24 plate castings being rejected of a total of 1,005 manufactured due to casting defects or dimensional inaccuracies. The cover castings were susceptible to shrinkage at the hinges and lifting lugs. This defect was reduced in severity by close control of pouring temperature. This particular casting was sensitive to the type of resin employed; stiff, high-tensile moulds causing mould failure on pour-off. Typical panel, cover and motor bracket castings are illustrated in Figs. 41, 13, and 42.

Another class of castings currently in production are spheriodal-iron clamps used in securing staging around ship hulls. All patterns were made in an aluminium alloy, as a weight-saving feature. The

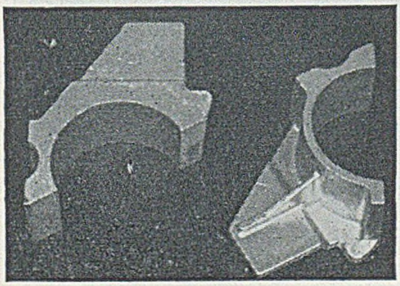


FIG. 42.—*(left) Ordnance Motor Bracket Castings, As-cast.*

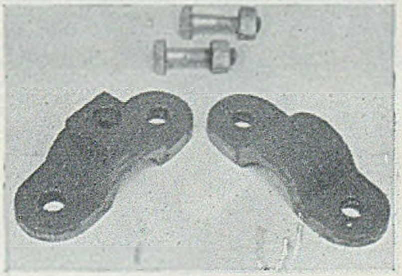


FIG. 44.—*(right) Staging Clamp Castings, As-cast.*

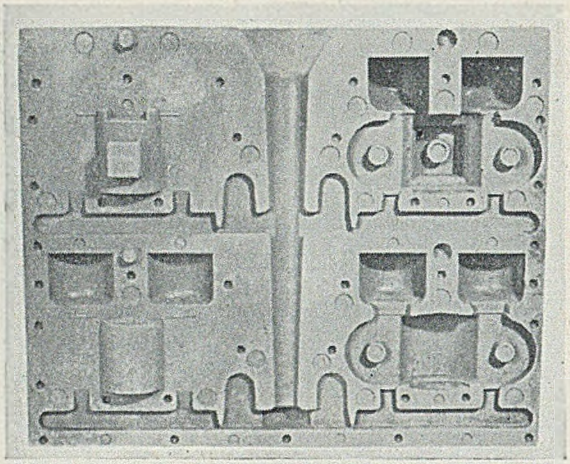


FIG. 45.—*Half-mould for Staging Clamp Castings.*

master patterns and castings for one of these clamp designs are shown in Figs. 43 and 44. It will be noted that the pattern is of the reversible-mould type, and that four castings of two designs are cast in each mould. The gating and heading was typical for ductile cast iron, incorporating heavily choked runners and ingates, together with skim bobs, and substantial risers, notched for easy removal by flogging. Moulding mixtures and cycles were similar to those employed on the aluminium castings described previously. Moulds were generally pasted together and bedded vertically, several to each box, using air vibrators to secure maximum compression of the shot during the bedding operation. A typical mould half is shown in Fig. 45. The castings produced were exceptionally smooth and required no further machining operations.

An example can be quoted of shell moulding in a 0.45 per cent. carbon steel where improved yield and the elimination of certain machining operations justified the use of the method even though very close tolerances and high surface finish were not particularly important. The master pattern, mould and core were shown previously in Figs. 10, 11, and 12.

The investment formula utilized on this job was varied somewhat from that previously described,

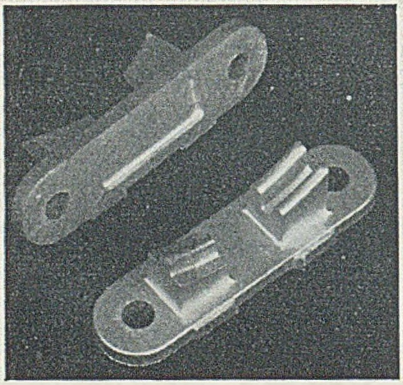


FIG. 46.—(*left*) *Aluminium Bomb-chocks, As-cast.*

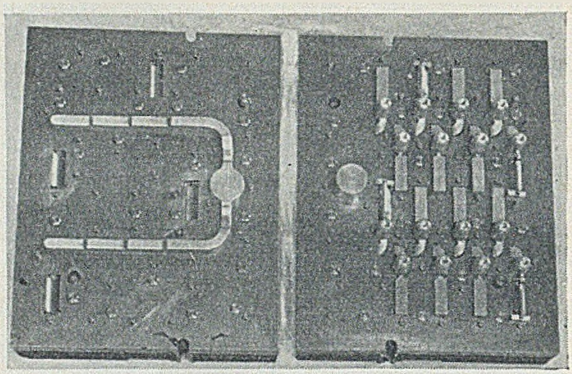


FIG. 47.—*Turbine-blade Patternplates.*

in order to combat the increased penetration and washing characteristics of medium carbon steel. The formulation generally employed for medium carbon steels, consisted of:—A.F.S. 230 sand (relatively high clay), 82.0 per cent; silica or zircon flour, 375 mesh, 7.5 per cent.; phenol-formaldehyde resin, 10.5 per cent.

It was found necessary to lengthen the dwell period for investments of this type to 25 to 30 sec., at 350 to 450 deg. F. (175 to 230 deg. C.) plate temperature to secure ¼ in. thick moulds. The curing time was not affected and averaged 60 sec. in the strip heater. The moulds were characterized by velvety, close-grained surfaces, firm edges, and good strengths. The moulds were bedded horizontally in steel shot, vibrated, and poured off in the temperature range of 2,900 to 3,000 deg. F. (1,590 to 1,650 deg. C.). Very little sand adherance to these castings was experienced in comparison with sand castings, and the resultant surface finishes were superior to sand castings, although not approaching the surfaces obtained in the non-ferrous, or grey-iron alloys.

Another shell-moulding casting application in an aluminium alloy is illustrated in Fig. 46. In this bomb chock casting, considerable machining time was eliminated. Still another application, steam turbine blades, currently under development for manufacture by the shell-moulding process, is illustrated in Figs. 47, 48, and 49. These blades are cast in a 410 stainless-steel alloy and poured horizontally. The gating arrangement shown

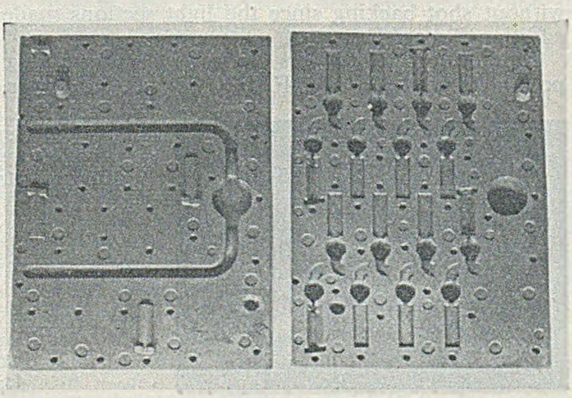


FIG. 48.—(*right*) *Turbine-blade Mould, Cope and Drag.*

yielded X-ray sound blades. On the basis of the development work accomplished to date, it is believed practical and economical to cast 410 stainless turbine blades of the size indicated and to finish to plan dimensions by an automatic grinding and machining operation. A light belt sanding as practised in the investment-casting field is sufficient to reduce the surface finish of these blades to an r.m.s. value of approximately 25.

In evaluating the applicability of any particular casting design to the shell-moulding process, it has been found profitable to discuss the casting tolerances and design with the design agency concerned. Frequently, tolerances are applied to a dimension of a part simply because in ordinary machining operations it is easy to attain. However, in many cases it is possible to open up tolerances on a piece if machining is to be completely eliminated. This has been accomplished, in many cases, without affecting the serviceability of the casting. In addition, design changes may sometimes make the difference between an economical productive casting method in shell and one which will give considerable difficulty in casting sound.

Shell moulds are also being utilized to some extent as a core carrier. Shell moulds coated with a high-temperature varnish will withstand numerous runs through a tower oven and provide a relatively cheap core carrier.

In any cost analysis of the shell-moulding operation, the cost of the resin employed will frequently represent 50 to 75 per cent. of the direct labour and raw material costs of manufacturing a mould or core, depending upon the degree of mechanization employed. Hence, any method or process which will reduce the conventional amounts of resin required to produce a shell mould or core of sufficient strength, will certainly be reflected in marked decreased costs, and may enlarge the area in which the process can be utilized.

There are many hidden advantages to the shell-moulding process which many operators have considered in deciding upon the applicability of any casting design to the shell-moulding process. Among them is a saving in foundry scrap due to dirt and trapped sand. Usually the defective moulds made by this process are eliminated prior to pouring. In addition, overheads, based on space required for a certain degree of productivity, are less than in conventional moulding. The smooth surfaces obtained in shell-moulded castings permits easy indentification of defects. It has been the experience of the Author that evidence of internal unsoundness of a shell-moulded casting can be detected by surface examination. However, in conclusion, it must be re-emphasized that this process is not a panacea for all foundry ills. In the final analysis, it probably will only replace a small percentage of conventional sand casting, but if properly applied to the right job can be a useful and economic tool.

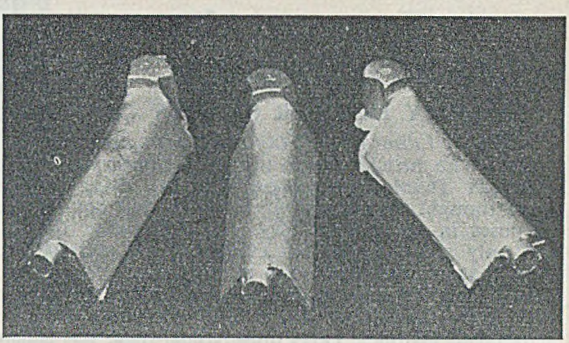


FIG. 49.—*Type* 410, *Stainless-steel Turbine-blade, As-cast.*

Acknowledgments

The Author wishes to express his appreciation to the Bureau of Ships, Navy Department, for authorizing this project and for granting permission to publish the results. Specifically, thanks are due to Captain H. T. Koonce, U.S.N., director of the Material Laboratory, for his interest and encouragement in this project; to Noah A. Kahn, head metallurgist, for his review and criticism, and to Mr. S. B. Donner for his assistance rendered in obtaining the data.

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A NEW ORDER for 10 Diesel-electric locomotives has been placed with Brush Bagnall Traction, Limited, Loughborough, by the Steel Company of Wales, Limited, for heavy-duty steelworks operation.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

FLUIDITY TEST FOR QUALITY CONTROL

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—The article under this title appearing in the FOUNDRY TRADE JOURNAL on May 21, 1953, prompts some thought on the use of a fluidity test for routine purposes in an iron foundry. In most cases, the test can only give post-morten evidence, and merely confirms that misruns are due to poor fluidity.

In a detailed investigation of the fluidity of molten cast iron (B.C.I.R.A., *Journal of Research and Development,* October, 1951) the present writer has shown that only pouring temperature and composition have any significant effect on fluidity. If, therefore, composition remains constant, fluidity varies directly with pouring temperature. It has also been demonstrated that pouring technique can seriously influence the length of a fluidity spiral, unless elaborate precautions are taken.

The author of the recent article quotes the case of a foundry where composition as it affects fluidity is virtually constant, but where ladle temperature varies ± 70 deg. C. Why not, then, measure pouring temperature instead of going to the trouble of making a mould, pouring the metal and measuring the resultant casting? Surely the measurement of temperature is quicker and not subject to the inaccuracies of a fluidity test which can be influenced by pouring technique.

The fluidity test is only of real value as a research tool to determine the effects of various factors on the fluidity of the metal and, once these factors are established, the information can be used in foundry practice. If misruns are being experienced in an iron foundry, casting a fluidity spiral will not correct the trouble; steps must be taken to increase the pouring temperature or, in certain cases, to change the design of the running system of the moulds giving trouble. In most foundries it is possible to divert suspected metal to heavier castings, which are less likely to misrun and to wait for hotter metal from the furnace at some later stage, for the more difficult castings.—Yours, etc.,

E. R. EVANS,
Research Department.

British Cast Iron Research Association,
July 7, 1953.

CURE FOR INDUSTRIAL MYOPIA

SIR,—While greatly appreciative of the kind reference in the leading article under the above title in your issue of July 9, I should like to correct a misapprehension which may arise. The booklet referred to on the work of the British Cast Iron Research Association's operational team was initiated, prepared and issued by the Council of Ironfoundry Associations. I was glad to accept their invitation to write the introductory note and provide facilities, but otherwise the credit should be given wholly to the C.F.A.—Yours, etc.,

J. G. PEARCE,
Director.

British Cast Iron Research Association,
Alvechurch, Birmingham.
July 11, 1953.

PLANS HAVE BEEN APPROVED for an addition in Western Road, Jarrow-on-Tyne, for Jarrow Metal Industries, Limited.

Foundry Accident Sequel

Sheriff John MacGregor, QC, has issued his considered judgment in an action raised in Falkirk Sheriff Court at the instance of Alexander Beattie, iron-moulder, against Carmuirs Iron Company, Camelon, Falkirk. Beattie sued defenders for payment of the sum of £2,500.

In his condescendence, Beattie stated that he was employed by the defenders. On or about March 17, 1950, he was carrying out his normal work in the moulding shop at Carmuirs Iron Works, and in the course of his work he had filled his ladle with molten metal from the bogie which had conveyed the metal from the furnace. As he walked over towards his box, he had to stand on a section of the floor which was sloping, and as he did so his foot slipped. In trying to regain his balance, the pursuer sustained a severe strain of his back, resulting in a prolapse intervertebral disc and was totally incapacitated from March 17, 1950, for about seven months. Since then, he has only been fit for intermittent light work which he has had to give up on every occasion owing to recurrence of his injury.

The pursuer also averred that the accident was caused by the fault or negligence of defenders in having inadequate and badly-constructed roadways leading to the moulders' boxes. Defenders knew or ought to have known that the sloping embankment of sand might cause a moulder carrying a full ladle to slip or stumble and therefore constituted a trap and a danger.

The defenders, in their submission, admitted that there was a slight slope leading from the roadway to pursuer's boxes, but the incline did not exceed one inch in six feet. They denied that the difference in levels was too great for a person carrying a heavy ladle of metal or that the accident was caused by their fault and negligence in having inadequate and badly-constructed roadways.

The Sheriff found that pursuer had suffered pain and was unable to resume his work as a moulder. Having sustained injury through the fault and negligence of defenders, the pursuer was entitled to reparation from them. The Sheriff assessed the sum due as solatium at £100, and net loss of wages at £341, a total of £441. He therefore granted a decree for the sum of £441, in favour of pursuer.

In a note accompanying his decision the Sheriff said: "After consideration I have come to the conclusion that pursuer is entitled to reparation from defenders for the injury sustained by him while in their employment. The main factor influencing me in making this decision is a dangerous operation even on level ground. To add to the danger by causing the workman to walk up this slope, even though a short one, appears to me to have been an addition to the already existing danger which could and should have been avoided.

"The Pursuer's procurator argued that in addition to sums for loss of wages and solatium the pursuer was entitled to a sum of money for diminished earning capacity. The evidence does not support this claim. It shows that pursuer is now able to earn, in another type of employment which he appears to be able to obtain, a weekly wage at least equal to the wage he earned as a moulder before the accident."

A small liaison committee, appointed to examine the possibility and desirability of a continued exchange of information on foundry productivity between Western European nations, met in Brussels on July 3. Among subjects discussed, it was provisionally agreed to arrange a half-day meeting in Paris during the period of the International Foundry Congress—possibly on the afternoon of September 22.

Personal

Mr. P. E. Trier, M.A., and Mr. G. Knott, M.A., A.M.I.E.E., have been appointed joint managers of the Mullard research laboratories.

Mr. G. S. Ramage, secretary of the Harland Engineering Company, Limited, Alloa, has been appointed to the Board of directors. He has been secretary since 1923.

Mr. John Glegg retired last week after 57 years' service in the patternmaking dept. of the Carron Company and was presented with a smoker's outfit by his colleagues.

Sir Geoffrey Herbert Savage, works director of the Rover Motor Company, Solihull, for three years president of the Birmingham branch of the Engineering and Allied Employers' Association, whose death was announced recently, left £31,094 (£14,903 net).

Mr. H. Eyles, secretary of thhe Birmingham Chamber of Commerce, who is shortly to retire after nearly 40 yrs. service, was presented with a clock on behalf of members of the Birmingham Junior Chamber of Commerce on July 3. Mr. H. T. Fost, president, made the presentation.

Mr. J. Roy Gordon, vice-president and general manager of Canadian operations of the International Nickel Company of Canada, Limited, has been elected a director of the company. He succeeds the late Mr. R. Leslie Beattie, who had been vice-president of the company since 1942 and a director since 1943.

Mr. J. W. Berry, joint managing director of a Birmingham aluminium castings concern, has been appointed a member of a committee of the Ministry of National Insurance which is to review the present provisions of the Industrial Injuries Act, in so far as it applies to benefits paid for diseases and for personal injuries not caused by accident.

Mr. J. Oddy has been appointed general superintendent of the engine factory, Austin Motor Company, Limited. Previously, he had been with the Ford Motor Company, and Midland Motor Cylinder Company, Limited. He is to continue personal supervision of the Austin foundry. Mr. G. M. Phillips has been appointed foundry superintendent under Mr. Oddy.

On the occasion of Her Majesty's Coronation, and in recognition of 50 yrs.' faithful service to Cruikshank & Company, Limited, Denny, the following employees were presented with gold wristlet watches:—Mr. John Pinkerton, Mr. Robert Howie, Mr. James Herd, Mr. James Mercer, and Mr. Alex. Binnie. The presentations were made by Mr. James K. Shanks, M.B.E., D.L., J.P., the chairman of the company.

The Institute's Motto

Mr. D. Howard Wood informs us that when seconding a vote of thanks to the president at the annual general meeting of the Institute of British Foundrymen he was incorrectly reported. Actually, he suggested that when the president examined the badge of office with which he had just been invested, he would find items of interest. Already he had referred to the motto of the Institute which was generally understood to be "Science Hand in Hand with Labour." A close examination of the badge showed that the donor had modified the original motto and made it to read "Science Hand in Hand with the *Dignity* of *Skilled* Labour." As was reported, he further suggested that in view of the importance of the two additional words, it might be worth while in the future considering the adoption of the latter version of the motto.

Monopolies Commission

The introduction into Parliament of a Monopolies and Restrictive Practices Commission Bill, which has received its first two readings in the House of Commons, indicates that the Government's policy is to place the commission on a more permanent basis. The purpose of the Bill is stated to be to strengthen the commission and enable it to deal at any one time with a greater number of references.

To this end, three principal changes are to be made. The chairmanship of the commission becomes a long-term pensionable appointment, and the Board of Trade is empowered to appoint up to two deputy chairmen—also on a long-term pensionable basis. The normal minimum age for retirement will be 65; retirement will be compulsory at 72, and there is provision for removal on grounds of incapacity or misbehaviour. The maximum membership of the commission is increased from 10 to 25. The functions of the commission will be exercisable by groups of not fewer than five members. In relation to any reference which has been remitted to it by the chairman, a group will have all the powers and duties assigned to the commission under the Monopolies Act and its report will be a "report of the commission" for the purposes of that Act. No conclusion in a group report will, however, empower the Government to take remedial action under the principal Act unless it is the conclusion of at least two-thirds of the group members.

The Bill relates only to the constitution and organization of the commission; it does not in any way modify the powers and duties of departments under the Monopolies Act.

Britain's "Grown-up Partner"

Paying a one-day visit to North Staffordshire during an industrial tour, Mr. John J. Cahill, Prime Minister of New South Wales, endeavoured to bring home to industrialists and workers in that area two important points. One was the extent of the expansion going on in the state of New South Wales, which contains the largest proportion of Australia's population and wealth, and the other that competition is fierce, especially from America, for help in setting up factories there. Mr. Cahill, after touring the works of the Shelton Iron, Steel & Coal Company, Limited, appealed for help from Britain in developing New South Wales. Australia, he said, must be regarded as a "grown-up partner" by Great Britain. New South Wales wanted Britain's help, even to the extent of setting up factories inland, for at the moment industry was confined to a strip of the coast. Formerly a fitter and turner, and for 27 years a member of the Amalgamated Engineering Union, Mr. Cahill took great interest in his visit to Shelton's works where, he said, so much steel had been made for development projects in his state.

The Board of Trade has announced that the Census of Production, to be taken early in 1954 in respect of the year 1953, will be on a sample basis. This is the second year in succession for this procedure, which means that most of the smaller establishments in the foundry industry will be spared the labour of returning these forms. The amount of detail required is also less than for some of the earlier censuses. Member-firms of the Council of Ironfoundry Associations may recall that, some years ago, the C.F.A. made representations against the complexity of the forms, and is pleased that official policy is finally showing some improvement.

News in Brief

THE MAIN SESSIONS at a sales conference held recently by George Kent, Limited, at Luton, were devoted to a detailed technical and commercial study of the new "KU" flow meter.

THE ORIGINAL bathing, washing and changing facilities installed at Glenfield & Kennedy, Limited, works at Kilmarnock have recently been greatly extended to cater now for 500 and ultimately for 1,000.

THREE FALKIRK foundry companies were fined £20, £30, and £50 at the local Sheriff Court on July 6 for contraventions of the Iron & Steel Scrap Order, 1950. All had bought scrap above the controlled price to keep their staffs employed.

THE MUTUAL SECURITY AGENCY mission to the United Kingdom has announced that $13,000 has been made available for the purchase of technical and scientific publications needed by British research associations. It is buying publications for 12 such associations, including the British Cast Iron Research Association.

WILD-BARFIELD ELECTRIC FURNACES, LIMITED, Elecfurn Works, Watford By-pass, Watford, Herts, have issued a general invitation to senior students of technical colleges and technical institutes to visit their works during the coming season from October to May. Readers would be well advised to apply as soon as possible for a suitable date.

THE INSTITUTION OF CHEMICAL ENGINEERS and Chemical Engineering Group are holding a Chemical Engineering Conference at Olympia, London, from September 7 to 11, during the period of the Engineering, Marine and Welding Exhibition and the Chemical Plant Exhibition. Nine papers and reports covering a wide range of subjects are to be presented.

THE ASSOCIAZIONE ITALIANA DI METALLURGIA, which has changed its address to via Moscova 16, Milan, Italy, is this autumn organizing two conferences. The first, covering the subject of corrosion, is to be held in Milan from October 8 to 10, and the second one—a symposium on the electrolysis of aluminium—in the same city from October 12 to 14.

FROM JULY 13 the Iron and Steel Board assumed their responsibilities under the Iron and Steel Act, 1953. The Board are in the course of arranging accommodation and staff. Offices are being equipped at Norfolk House, St. James's Square, London, S.W.1 (tel. WHI 6931), which is the Board's headquarters and where there is already a nucleus staff.

A £2,000,000 SCHEME to modernize berthing and handling facilities for large liners using the Port of Glasgow was unanimously approved by the Clyde Navigation Trustees on July 7. The scheme, which is additional to an earlier (£1,770,000) reconstruction programme will take 3 yrs. to complete. It includes 41 new cranes at five docks, and goods sheds at three.

HIS ROYAL HIGHNESS, the Duke of Edinburgh, has graciously consented to be patron of the International Scientific Film Association (I.S.F.A.) Conference to be held in London from September 18 to 27. The conference will take place in the National Film Theatre and the Royal Festival Hall. Scientific films from all over the world will be displayed.

A 10-DAY VISIT to Sweden by Mr. E. R. Dunsby, sales-manager of G. Clancey, Limited, of Belle Vale, Halesowen has produced valuable orders for the firm with prospects of more to follow. The firm manufactures template parts, mainly valve guides and tappets for motor-cars. Substantial orders were obtained from the firm of Scaniavalvis, commercial-vehicle builders.

A COPPER-AND-IVORY TROWEL and a silver inkstand made by Deakin & Francis, Limited, of Regent Place, Birmingham, were specially commissioned for use by Queen Elizabeth the Queen Mother during her visit to Southern Rhodesia. Her Majesty used the inkstand when she opened the Rhodes Centenary Exhibition and received the trowel when, on July 13, she laid the foundation stone of the Rhodesia University.

WITH THE PASSING of the arctic winter, salvage work has been resumed on the former German battleship Tirpitz at Tromso, in North Norway, and four of the biggest guns of the battleship, each weighing 150 tons, which had been buried in mud at the bottom of Tromso fjord, have been recovered by the salvage company. The company estimates that 40,000 tons of steel plates are still left, and they do not expect work to be concluded before 1956.

BECAUSE OF THEIR EAGERNESS to finish work and begin their annual holidays, 25 Falkirk moulders will end their summer break looking for another job. The moulders, employed by Carron Company, Falkirk, wanted to down tools at 2 p.m. for the beginning of the holidays, but the management insisted on the usual finishing time of 4 p.m. Despite a warning that disregard of this order would mean suffering the consequences, the men left the moulding shop at noon.

JOSEPH TOMEY & SONS, LIMITED, Birmingham, are celebrating their centenary this year. Beginning in a small way 100 years ago, the firm has expanded into four organizations with interests throughout the world. It manufactures pressure gauges at its Aston factory and other firms in the organization make phosphor-bronze bushes, non-ferrous castings and chill-cast sticks, and aluminium and zinc-base die-castings. The firm supplied the first oil gauge to Lord Nuffield (then Mr. W. R. Morris), and since then Tomey "Eureka" oil gauges have been specified on all Nuffield products.

AT HAWARDEN BRIDGE steelworks, last week, Mr. A. Reith Gray, general manager and a director of John Summers & Sons, Limited, unveiled a Coronation Shield made by one of the apprentice joiners. The shield is to commemorate the formation at the time of the Coronation of the John Summers' Apprentice Association, membership being open to past and present apprentices. It will also be inscribed each year with the name of the best apprentice of the year, nominated by his fellow apprentices. The honour this year fell to Mr. J. C. Dawson, of Shotton. Aged 20, he is the first chairman of the Association; Mr. Gray is president.

THE BRITISH STANDARDS INSTITUTION, in its Monthly Information Sheet for June, under the heading "Amendment Slips Issued," announces amendment No. 1 to Specification 1760:1951, carbon steel castings for surface hardening. The reference number is PD 1630. "New Work Started" includes verification of testing machines (revision of B.S. 1610, Part 1), and "Reprints": B.S. 821:1938, iron castings for gears and gear blanks (3s. 6d.); CP 332.301:1947 space heating by means of independent gas appliances (3s. 6d.), and L 101:1950, inspection and testing procedure for aluminium ingots, aluminium-alloy ingots and castings, magnesium ingots, magnesium-alloy ingots and castings (2s. 6d.). "Draft Standards Circulated for Comment" include CR 3193: methods for the determination of cobalt, copper and chromium in iron and steel.

Raw Material Markets

Iron and Steel

Conditions in the iron trade show little variation from week to week. Apart from the anxieties shared by all industrialists concerning fuel supplies, blast-furnace operators have ample tonnages of raw materials at their disposal and are maintaining high outputs. Stocks of pig-iron have also been raised to a satisfactory level and may be further increased during the next few weeks, when consumption is likely to be affected by the summer holidays. Buyers of foundry iron are able to obtain prompt deliveries and possibly current production is not fully absorbed, owing to the prevailing slackness in the light-castings trade, but there is a healthy market for all other grades of iron, and foreign hematite still figures in the list of imports.

Although there has been some improvement of late in the deliveries of semi-finished steel from British steel plants, substantial tonnages of foreign semis are still in circulation. The scarcity of the smaller sizes of billets has not yet been overcome, and considerable tonnages of foreign slabs are being used in the sheet mills. Ample tonnages of home-produced semis, however, are now in sight, and a sensible reduction in the high rate of imports is promised in the next few months. Re-rollers are still fairly busy, but the continued lack of foreign business is disquieting and replacement of orders in process of execution is becoming a matter of some urgency.

Activity in the heavy steel trade is well maintained and pressure for prompt deliveries of steel plates is undiminished. It is understood that deliveries to the shipyards have been increased by about 5 per cent., but this falls far short of requirements, and further supplies are sought from oversea sources. Maximum deliveries of heavy rails and sections are still required, but trade in small sizes of angles, rounds, and flats is quiet, and only the fortuitous bookings of orders from the United States and Canada have kept the sheet mills fully employed. Tubemakers have placed substantial orders for strip, and the motor trade and other users are well supplied with sheets.

Non-ferrous Metals

The Ministry of Materials has announced that its stock of zinc likely to be remaining on August 1 will be some 64,000 tons; as from that date, when the provisional disposal plan will have terminated, the Government intends to sell from its stocks at the rate of 2,000 tons per month, which is about half the present disposal rate. It is understood that this rate is subject to variation in need, but the market now knows how it stands and the trend of prices is likely to be more up than down. Under the new plan sales will normally be made by the Ministry to the producers' agents and through other members of the Metal Exchange.

The outlook in tin is certainly very obscure, but even after the drastic fall that has taken place in prices there is a tendency to look for still lower quotations. Much depends on America's stockpiling plans. In the meanwhile, it has been announced that the U.S. is ready to sign up for 12 months to purchase tin from Bolivia at the world price ruling at the time of delivery of the metal. Whether anything will come of this remains to be seen.

Figures issued by the British Bureau of Non-ferrous Metal Statistics show that only 14,779 tons of virgin copper were consumed in the U.K. in May. This was more than 1,000 tons below the April figure. Usage of scrap copper in May was 18,100 tons, or about 500 tons down on the previous month. Stocks again increased and the total of virgin copper on hand at May 31 was 182,500 tons, which compares with 165,400 tons at April 30. As may be supposed, total usage of copper this year is so far well below last year's comparative figure and, according to the bureau, the five month's tonnage to May 31 this year was 187,416, against 256,807 in 1952. Consumption of zinc in the U.K. for the first five months of this year was 103,678 tons, compared with 119,367 tons in the corresponding period of last year. In May the country consumed 20,105 tons, of which 13,935 tons was virgin metal. Stocks in the U.K. at May 31 were 34,078 tons, an increase of 3,250 tons on the previous month. Lead stocks also advanced, the May figure of 29,000 tons being nearly 12,000 tons more than April. Total consumption of virgin, scrap, and remelted lead in May was 24,350 tons. Consumption of tin in May was 1,351 tons, a poor month.

The Minister of Supply has made an Order to come into operation on August 5 revoking the Copper, Lead and Zinc Distribution Orders. The effect of this Order is that when the London Metal Exchange resumes dealings in copper next month, licences will no longer be required for the purchase of any form of copper.

Official tin quotations were as follow:—

Cash—July 9, £625 to £630; July 10, £622 10s. to £624; July 13, £596 to £597 10s.; July 14, £590 to £592 10s.; July 15, £580 to £582 10s.

Three Months—July 9, £625 to £627 10s.; July 10, £618 to £620; July 13, £595 to £600; July 14, £590 to £592 10s.; July 15, £580 to £582 10s.

The following official zinc prices were recorded:—

July—July 9, £73 to £73 5s.; July 10, £73 7s. 6d. to £73 10s.; July 13, £72 10s. to £72 15s.; July 14, £71 15s. to £72 5s.; July 15, £74 10s. to £74 15s.

October—July 9, £73 5s. to £73 10s.; July 10, £73 10s. to £73 15s.; July 13, £72 10s. to £72 15s.; July 14, £72 5s. to £72 10s.; July 15, £74 10s. to £74 15s.

Official prices of refined pig-lead were:—

July—July 9, £92 15s. to £93; July 10, £93 to £93 5s.; July 13, £91 10s. to £91 15s.; July 14, £89 10s. to £90; July 15, £92 to £92 10s.

October—July 9, £90 10s. to £90 15s.; July 10, £90 5s. to £90 10s.; July 13, £89 to £89 5s.; July 14, £87 10s. to £87 15s.; July 15, £89 to £90.

Push-Button Factory in Sight

A speaker at the recent conference of the British Institute of Management, Mr. F. G. Woollard, a director of Birmingham Aluminium Casting (1903) Company, Limited, claims that the automatic "push-button" factory is not only in sight, but is an economic necessity for certain sections of industry. Soon, new tools of production—some of them already in use both in this country and overseas—will virtually eliminate repetitive work from the mass-production industries, but as an offset to redundancy of labour there will be a great increase in maintenance, supervisory, and administrative staff. The problem will be one of redeployment, not unemployment, and the new methods will result in lighter and more interesting jobs, lower cost of production, and higher wages. He believes that Britain's standard of living, threatened by cheap labour in other countries, can be secured.

MR. OLIVER SMALLEY, O.B.E., president of the Meehanite Metal Corporation of America and a director of International Meehanite Metal Company, Limited, London, has arrived in this country and is expected to stay until the end of August.

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

(Delivered unless otherwise stated)

July 15, 1953

PIG-IRON

Foundry Iron.—No. 3 Iron, Class 2 :—Middlesbrough, £13 18s.; 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., d/d Grangemouth.

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

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £19 3s.; 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.; Scotland (Scotch iron), £16 18s. 6d.; Sheffield, £17 13s.; 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., basis 45 per cent. Si, scale 21s. 6d. per unit; 70/84 per cent., £82 10s., basis 75 per cent. Si, scale 23s. per unit.

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

Ferro-molybdenum.—65/75 per cent., carbon-free, 10s. to 11s. 6d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £204 to £210 per ton; 38/40 per cent., £235 to £265 per ton.

Ferro-tungsten.—80/85 per cent., 21s. 10d. to 22s. 6d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 24s. 8d. to 27s. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent. C, £85 4s., basis 60 per cent. Cr, scale 28s. 3d. per unit: 6/8 per cent. C, £80 17s., 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. per lb.

Metallic Chromium.—98/99 per cent., 6s. 5d. to 7s. 6d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £262 to £275 per ton; 96/98 per cent., £280 to £295 per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 40s. to 70s. 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; silico-manganese, £33 16s. free-cutting, £28 16s. 6d. Siemens Martin Acid: Up to 0.25 per cent. C, £32 12s.; case-hardening, £33; silico-manganese, £34 17s. 6d.

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

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.; 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.; 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.—Electrolytic, £252; high-grade fire-refined, £251 10s.; fire-refined of not less than 99.7 per cent., £251; ditto, 99.2 per cent., £250 10s.; black hot-rolled wire rods, £261 12s. 6d.

Tin.—Cash, £580 to £582 10s.; three months, £580 to £582 10s.; settlement, £580.

Zinc.—July, £74 10s. to £74 15s.; October, £74 10s. to £74 15s.

Refined Pig-lead—July, £92 to £92 10s.; October, £89 to £90.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £101 5s.; rolled zinc (boiler plates), all English destinations, £99; zinc oxide (Red Seal), d/d buyers' premises, £90.

Other Metals.—Aluminium, ingots, £150; magnesium, ingots, 2s. 10½d. per lb.; antimony, English, 99 per cent., £225; quicksilver, ex warehouse, £70 to £70 10s. (nom.); nickel, £483.

Brass.—Solid-drawn tubes, 23¼d. per lb.; rods, drawn, 32¾d.: sheets to 10 w.g., 256s. 3d. per cwt.; wire, 30¼d.; rolled metal, 243s. per cwt.

Copper Tubes, etc.—Solid-drawn tubes, 28¾d. per lb.; wire, 282s. 9d. per cwt. basis; 20 s.w.g., 311s. 9d. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £160 to £170; BS. 1400—LG3—1 (86/7/5/2), £172 to £190; BS. 1400—G1—1 (88/10/2), £254 to £285; Admiralty GM (88/10/2), virgin quality, £252 to £300 per ton, delivered.

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

Phosphor Bronze.—Strip, 364s. 6d. per cwt.; sheets to 10 w.g., 386s. 3d. per cwt.; wire, 45½d. per lb.; rods, 40¼d.; tubes, 38¼d.; chill cast bars: solids 3s. 3d., cored 3s. 4d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Ingots for raising, 2s. 5¾d. per lb. (7 per cent.) to 3s. 8¾d. (30 per cent.); rolled metal, 3 in. to 9 in. wide × .056, 2s. 11¾d. (7 per cent.) to 4s. 2¾d. (30 per cent.); to 12 in. wide × .056, 3s. to 4s. 3d.; to 25 in. wide × .056, 3s. 2d. to 4s. 5d. Spoon and fork metal, unsheared, 2s. 8¾d. to 3s. 11¾d. Wire, 10 g., in coils, 3s. 6½d. (10 per cent.) to 4s. 8¾d. (30 per cent.). Special quality turning rod, 10 per cent., 3s. 5½d.; 15 per cent., 3s. 11½d.; 18 per cent., 4s. 4d. All prices are net.

Obituary

THE DEATH has occurred of MR. NORRIS WAINWRIGHT, managing director of James Wainwright (Wolverhampton), Limited, at the age of 61. Mr. Wainwright founded the firm in 1929, and has been prominent in the motor industry for many years.

MR. CLEMENT T. RHODES, founder and managing director of C. T. Rhodes, Sons & Company, Limited, engineers, and a director of Merlin Engineering Company, Limited, and of Limitations Inunity, Limited, Diesel fuel-injection high-precision lapping equipment makers, all of Salterhebble, Halifax, died at the age of 63.

MR. MANLEY COOPER, chairman of Hills (West Bromwich), Limited, roof glazers, Woodfield Hoist & Associated Industries, Limited, Rochester (Kent), and Autoflow Engineering, Limited, optical machinery manufacturers, of Birmingham, died recently at the age of 60. He was also a director of Charterhouse Industrial Development Company, and represented it on the Boards of numerous companies with which they are connected.

The death has taken place at the works of Sulzer Bros., Limited, Winterthur, Switzerland, of DR. ROBERT SULZER, at the age of 80. He had spent more than 50 years in the family engineering concern. After being educated at Winterthur, Lausanne, and Zurich, where he received his diploma in the Swiss Federal Institute of Technology, in 1898, Dr. Sulzer made several visits abroad for practical engineering training. In 1901 he entered Sulzer Bros., becoming a partner in 1906. When the firm was converted into a limited liability company in 1914, he was appointed a managing director, an appointment he held until 1941.

Board Changes

IMPERIAL CHEMICAL INDUSTRIES, LIMITED—Viscount Weir has retired from the Board.

MR. E. W. HANCOCK has been appointed director and general manager of Humber, Limited, Coventry.

METROPOLITAN GAS METERS, LIMITED—Mr. G. P. Smith and Mr. W. A. Dobson have been elected directors.

HARLAND ENGINEERING COMPANY, LIMITED—Mr. G. S. Ramage, secretary since 1923, has been appointed to the Board.

J. SAMUEL WHITE & COMPANY, LIMITED—Lord Glyn, previously Sir Ralph Glyn, M.P., has been elected deputy chairman.

NATIONAL SMELTING COMPANY, LIMITED—Mr. H. L. Thompson has been elected a director of the company, which is a subsidiary of the Imperial Smelting Company, Limited.

LIGHTALLOYS, LIMITED—Mr. C. K. T. Marshall has been appointed managing director, in succession to Mr. W. S. Knight, who has resigned from the Board owing to ill health.

PEGLERS, LIMITED—Mr. A. E. Pemberton, managing director, has been elected vice-chairman in succession to Mr. F. E. Pegler, who has resigned for health reasons, but remains on the Board.

SCOTTS' SHIPBUILDING & ENGINEERING COMPANY, LIMITED—Mr. George Hilton, shipbuilding manager, and Mr. John Rennie Duncan, engineering manager, have been appointed directors.

MAJ.-GEN. SIR RICHARD LEWIS, MR. EDGAR W. PERCIVAL, and MR. ARTHUR WOOD, have joined the Board of Henry Meadows, Limited. MR. F. H. HARRIS and MR. E. H. L. COOPER have been appointed joint general managers.

CLASSIFIED ADVERTISEMENTS

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

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

SITUATIONS WANTED

FOUNDRY FOREMAN MANAGER desires change. 30 years' experience light castings, jobbing, mechanisation, and plate. Energetic, strong disciplinarian. Excellent record.—Box 3598, FOUNDRY TRADE JOURNAL.

METALLURGIST (28) requires progressive position. Midlands or South. B.Sc., A.I.M., A.M.I.B.F. Several years' senior research experience on cast ferrous metals.—Box 3558, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN desires change. Fully practical man, life experience trade. Machine tool, jobbing and mechanised iron foundries. Take full responsibility running and development. Training green labour.—Box 3601, FOUNDRY TRADE JOURNAL.

MANAGER (45), experienced foundryman, seeks position with progressive company. Experience full control light-heavy jobbing repetition and mechanised foundries, iron and non-ferrous. Estimate costings, sales, and office control. Good organiser, able to get results.—Box 3602, FOUNDRY TRADE JOURNAL.

PATTERNSHOP SUPERINTENDENT (36 years of age), married, seeks position offering scope for initiative. Fully conversant with the production of medium and heavy engineering castings. Able to estimate and introduce piecework schemes. Specialist in production planning and job control. Travelled extensively overseas as firm's Representative. Established and laid out patternshop employing 40 men on piecework. Past positions held include production engineer, chief rate fixer with firms of repute. At present completing overseas contract. Willing to accept any position allied with the foundry trade. Available from October.—Box 3597, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18-64 inclusive or a woman aged 18-59 inclusive unless he or she, or the employment, is excepted from the provisions of the Notification of Vacancies Order 1952.

FOUNDRY FOREMAN required to assist Superintendent of a large mechanised Foundry in Yorkshire, producing high grade Steel and Iron Castings. Applications are invited from men with first-class steel foundry experience, together with a good general knowledge of wood and metal patternmaking. A good salary will be paid and applicants are invited to write, giving full details of experience and particulars of present and past appointments, to Box 3567, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

ASSISTANT WORKS MANAGER for Steel Foundry required for Glasgow Area. Please state experience and salary required.—Write Box 3609, FOUNDRY TRADE JOURNAL.

METALLURGIST for Steel Foundry required for Glasgow Area. Please state experience and salary required.—Write Box 3610, FOUNDRY TRADE JOURNAL.

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

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FOUNDRY FOREMAN required for medium sized Midland Foundry producing Ferrous and Non-Ferrous castings. Must be experienced in Jobbing, oddside and Machine Moulding. State age, experience and salary required.—Box 3613, FOUNDRY TRADE JOURNAL.

METHODS ENGINEER required by large mechanised Iron and Steel Foundry in Yorkshire. Applications are invited from men holding similar position. Please write stating qualifications and details of past and present appointments to Box 3566, FOUNDRY TRADE JOURNAL.

METAL PATTERN PLATE FITTER, with experience in pattern making, wood and metal (moulders apprenticeship an advantage) as assistant foreman in a malleable iron foundry in the Home Counties. Permanent position with good prospects.—Apply giving full details of age, experience, etc., to Box 3562, FOUNDRY TRADE JOURNAL.

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KENRICK TECHNICAL COLLEGE
Principal: K. G. Lewis, M.Sc.

APPLICATIONS are invited for the post of Assistant (Grade A) in Foundry Work and Pattern Making. Applicants must have teaching experience, either full-time or part-time, possess a City and Guilds Final Certificate in Pattern Making, have had good general experience in a Pattern Shop and be acquainted in a practical sense with foundry production. Salary in accordance with the Burnham Technical Report, 1951, as revised, £415 by £18 to £670.

Application Forms, which may be obtained from the undersigned, should be returned to the Principal within 14 days of the appearance of this advertisement.

J. H. TURNER,
Director of Education.

Education Offices,
Highfields,
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SITUATIONS VACANT—*Contd.*

SALES REPRESENTATIVE for Malleable Ironfounders. Must have necessary technical knowledge of Foundry trade. Good position for man with drive and personality. Resident London Area.—Apply Box 3611, FOUNDRY TRADE JOURNAL.

MALLEABLE IRONFOUNDERS seek Sales Representative in Yorkshire, Lancashire and the North. Foundry and technical experience essential.—Apply Box 3612, FOUNDRY TRADE JOURNAL.

METALLURGIST required for Foundry, near South Coast, producing high duty Cast-irons. Experience of cupola control and mechanised foundry practice essential. Only men with first-class experience need apply. Housing accommodation available to suitable applicant.—Write, stating age, full details of experience, and salary required, to Box N.420, c/o STREETS, 110, Old Broad Street, E.C.2.

PATTERNSHOP SUPERINTENDENT AND FOUNDRY LIAISON SUPERVISOR (age 40) requires progressive position in Birmingham area. Full control in design, layout, and production of first-class wood and metal equipment for aero, automobile and general engineering industries, for latest foundry production methods—high duty grey iron and light alloy castings.—Box 3606, FOUNDRY TRADE JOURNAL.

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MEDIUM sized company producing high quality grey iron castings intend to appoint Agents in the London and Birmingham areas. Payment will be on a generous commission basis and it is essential that applicants have an established connection in the areas mentioned. A knowledge of foundry practice is also desirable.—Reply to Box 3607, FOUNDRY TRADE JOURNAL, and applicants for the London area mark the envelope L.A.

WORKS MANAGER, preferably with experience of Non-Ferrous Valve Trade, required for Company near Glasgow. Good education and some knowledge of administration essential, as post eventually leads to top executive position. Age 30 to 40. Fullest particulars with references and commencing salary expected should be given.—Box 3608, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

TECHNICAL REPRESENTATIVE required to represent an important Ferro-Alloys Manufacturer in the Scottish Area. Only men with intimate knowledge of the principal manufacturing processes in cast iron and steel metallurgy need apply. Preference given to applicants with L.I.M. or A.I.M. qualifications.—Apply, stating age, experience and salary, to Box 3593, FOUNDRY TRADE JOURNAL.

ASSISTANT METALLURGIST required (age 20-25) for training in experimental and routine practical metallurgy in Yorkshire Steel Foundry. Must have initiative and preferably technical education and experience.—Full details to Box 3583, FOUNDRY TRADE JOURNAL.

PATTERNMAKER FOREMAN required for Master Patternshop employing 20 (East Midlands area). Wood and metal patterns.; modern workshop.—Reply, stating age and experience, Box 3596, FOUNDRY TRADE JOURNAL.

GENERAL MANAGER required for well-known Modern Medium-Heavy Non-ferrous Founders and Chill Casters. Wide experience, estimating, costing, sales, market research, buying, etc. First-class man at top grade level, with energy and personality to pursue policy of vigorous expansion. — Write in first instance, giving fullest details, to Box 3599, FOUNDRY TRADE JOURNAL.

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GENTLEMAN, qualified Metallurgist and Industrial Chemist, wishes to invest £3,000 and take an active interest in a small Foundry in London area, or other industrial concern where his qualifications and experience could be used to good advantage.—Apply Box 3605, FOUNDRY TRADE JOURNAL.

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Applications are invited for admission to the Diploma Course, which opens on 21st September, 1953. Sufficiently qualified candidates may enter directly into the final year.—Individuals and firms in the foundry industry who are interested in advanced foundry training should write for particulars regarding entry qualifications, scholarships, hostel accommodation, etc., to the HEAD, National Foundry College, Wulfruna Street, Wolverhampton.

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Permission to inspect may be had from the following to whom offers in writing should be submitted on or before the 5th August, 1953.

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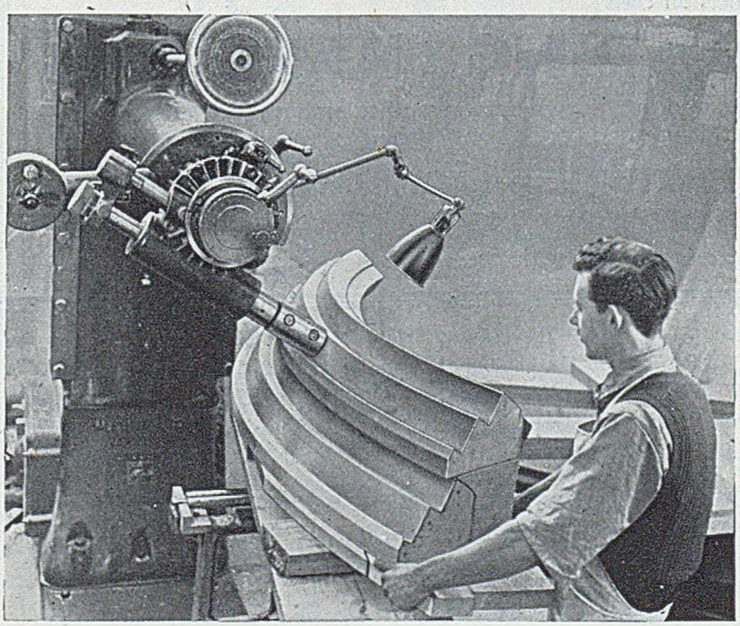

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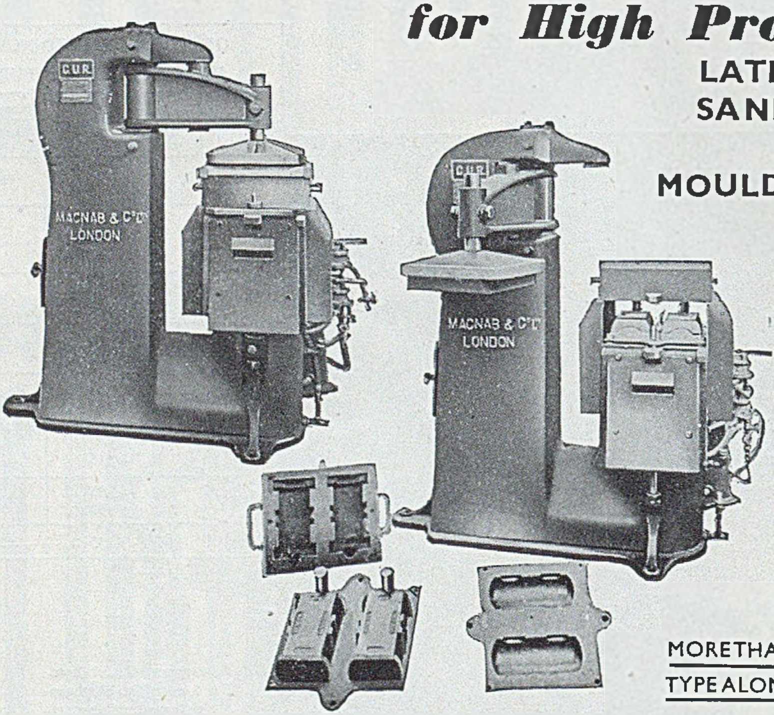

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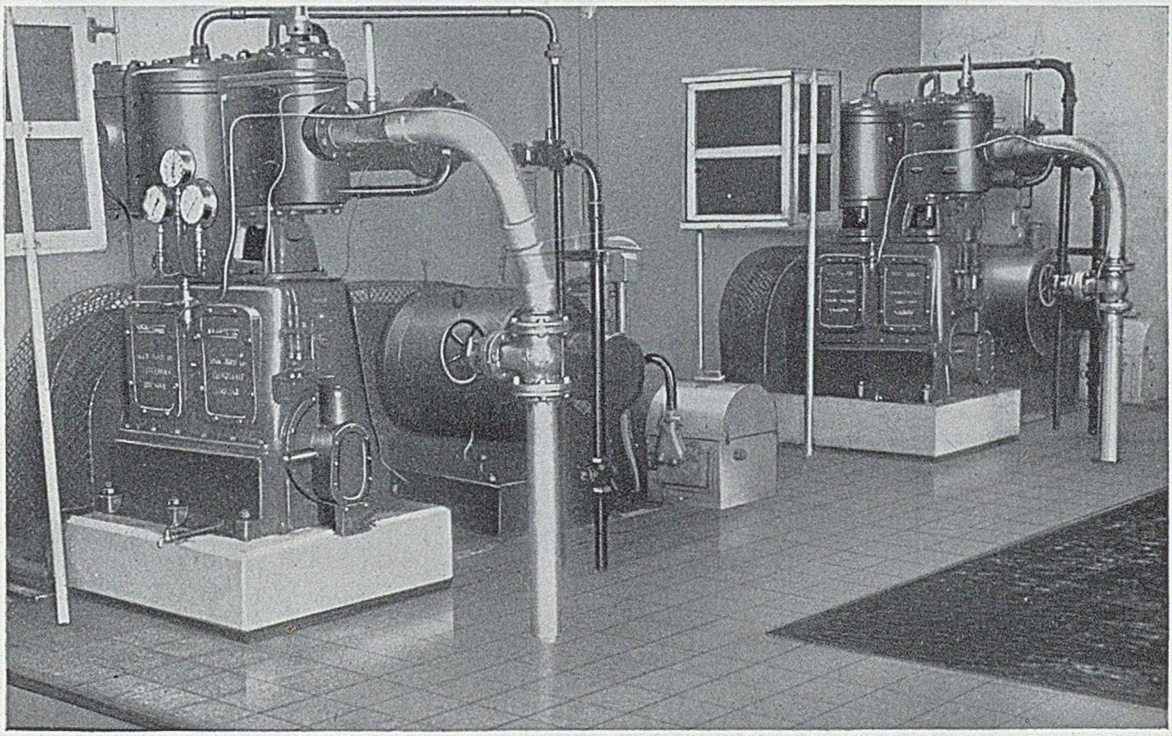

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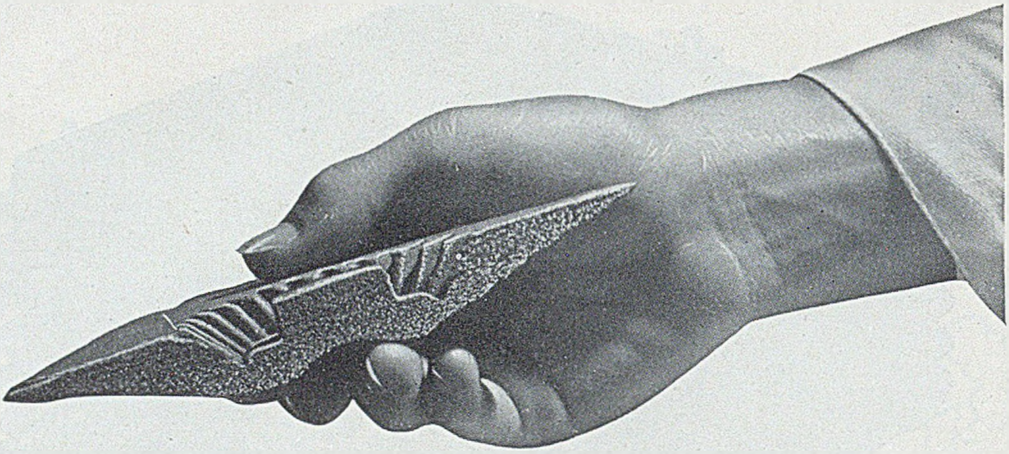

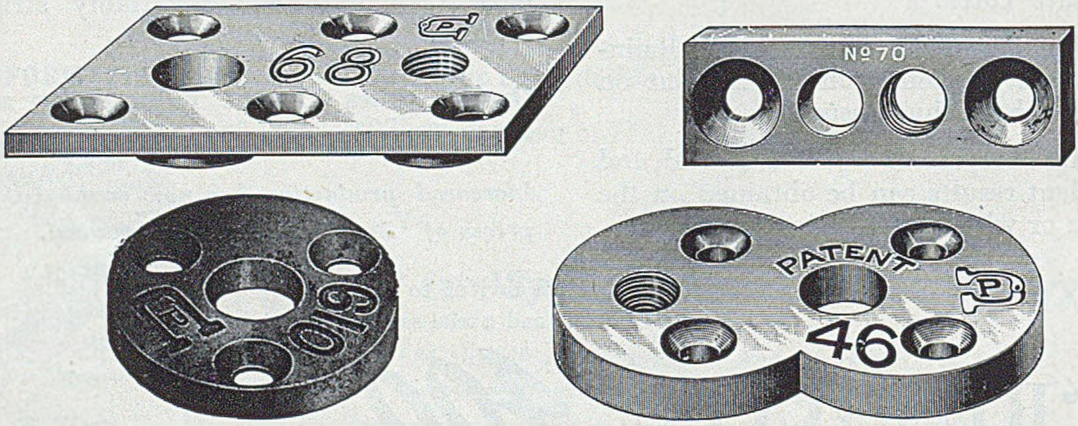
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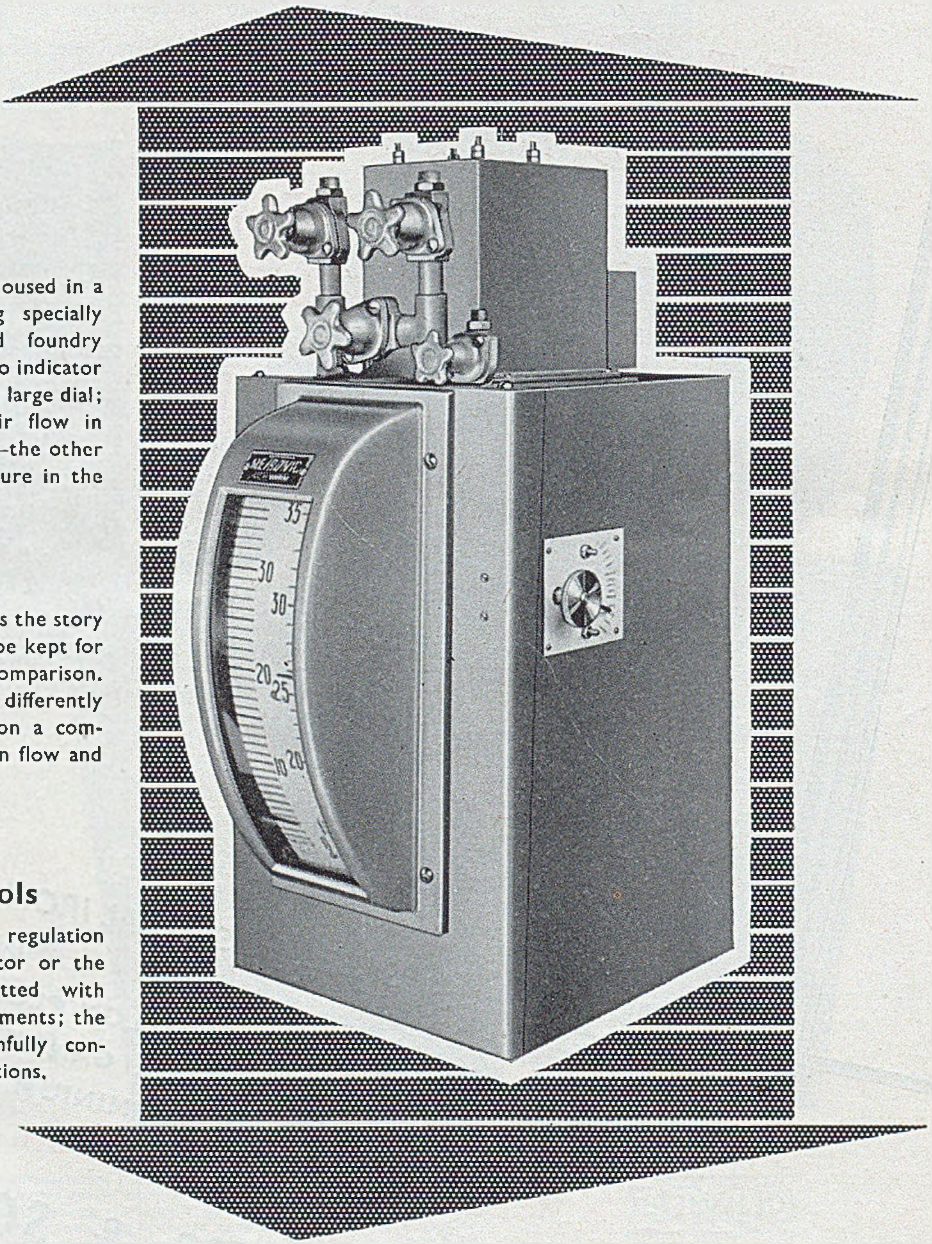

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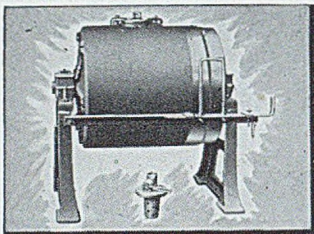

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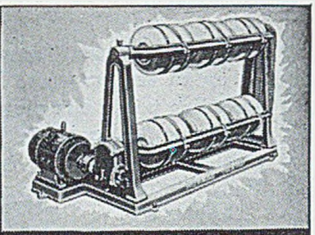

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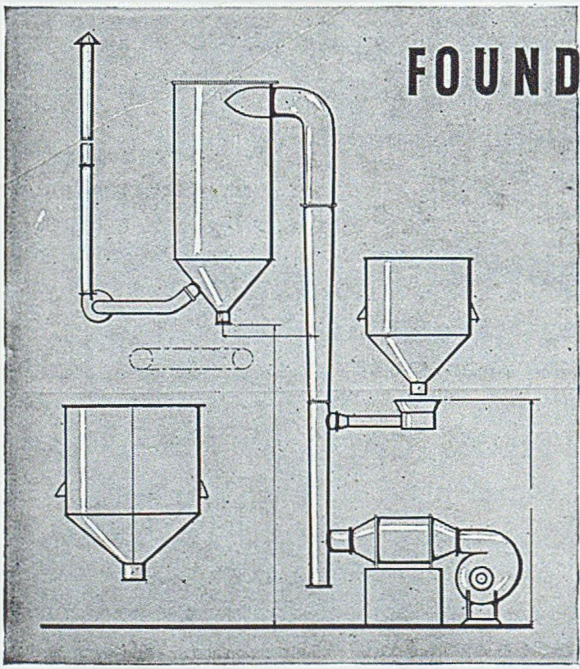

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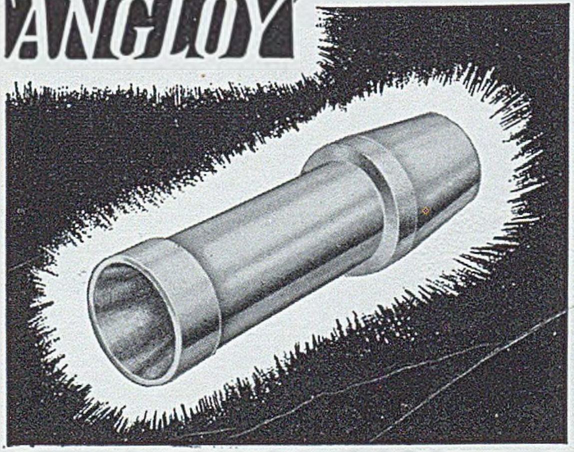

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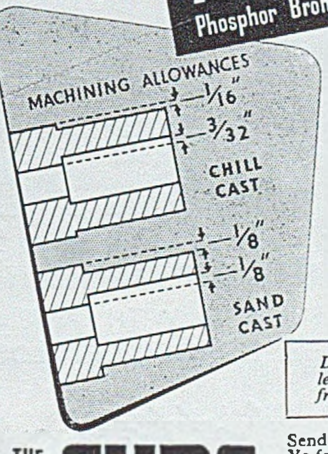

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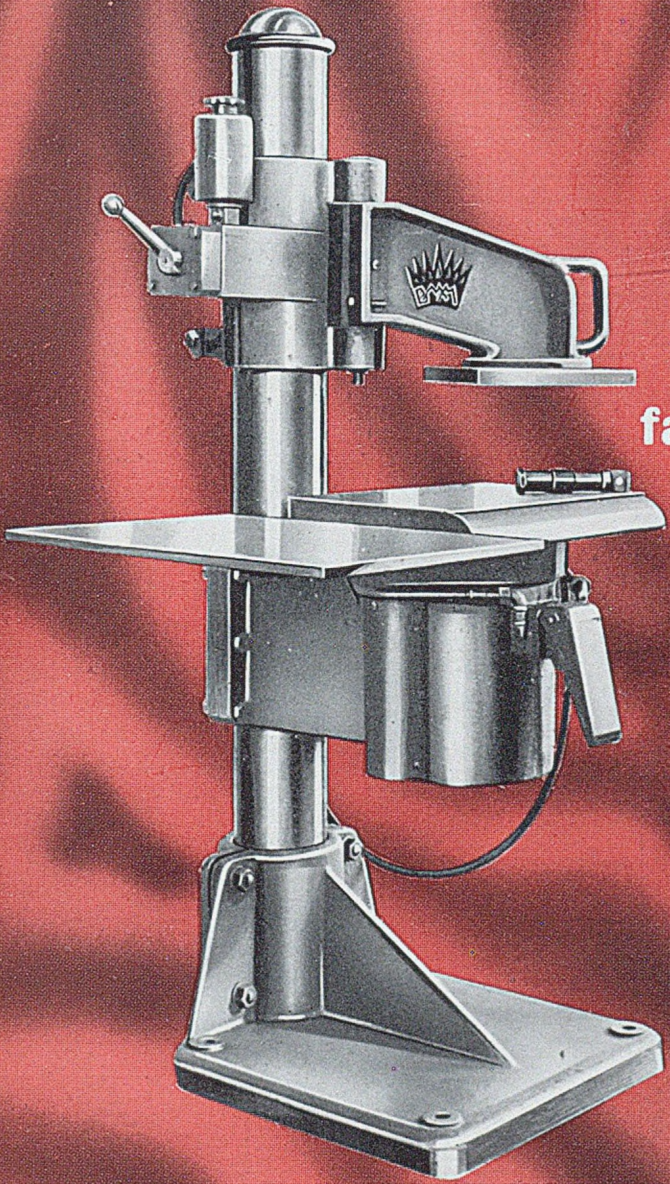

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