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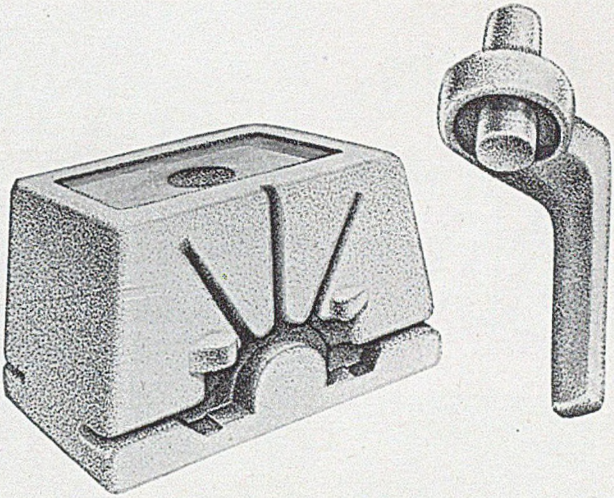

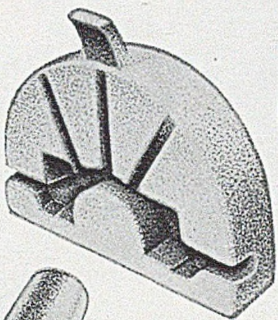

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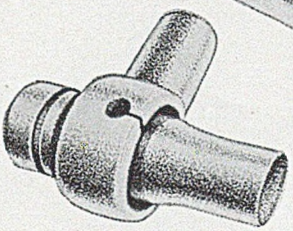

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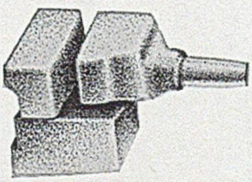

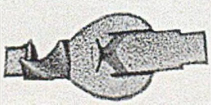

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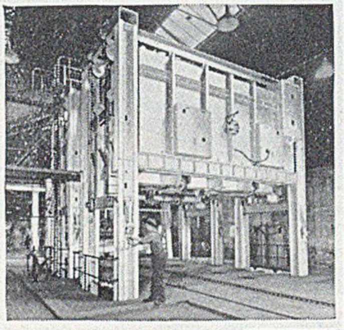

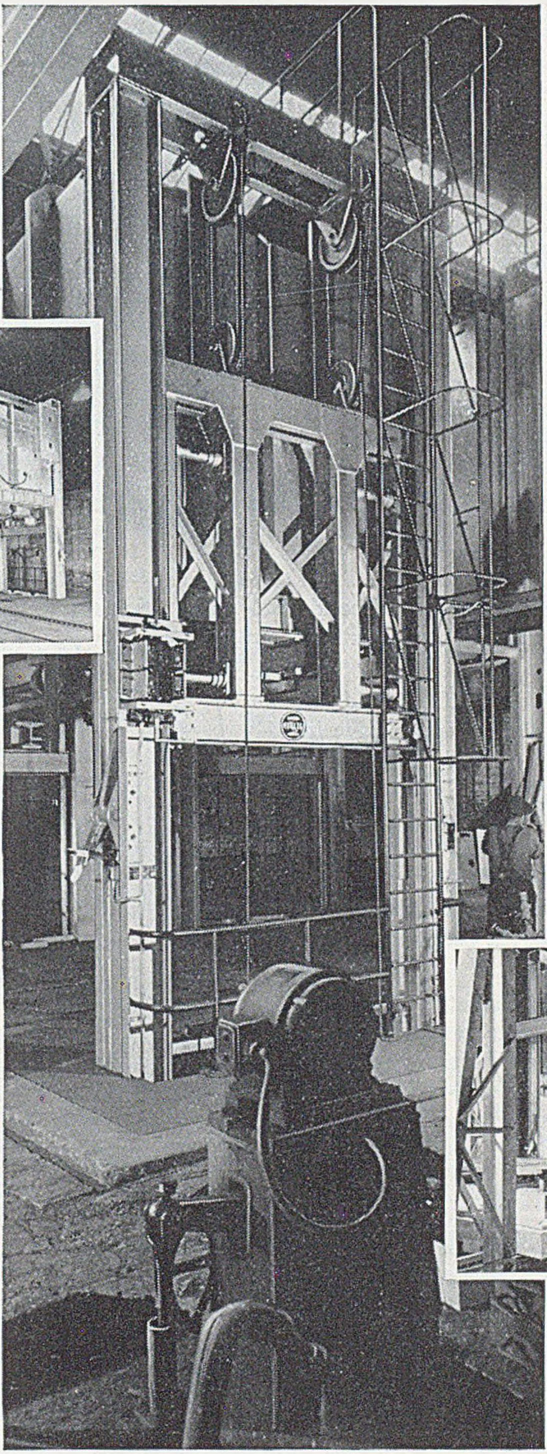

gaseous blackheart malleable annealing

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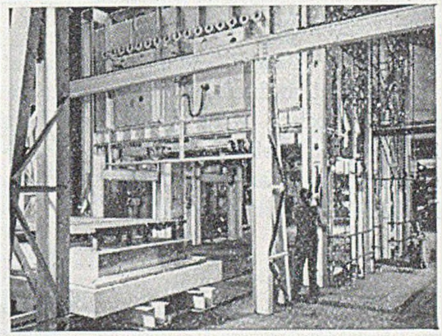

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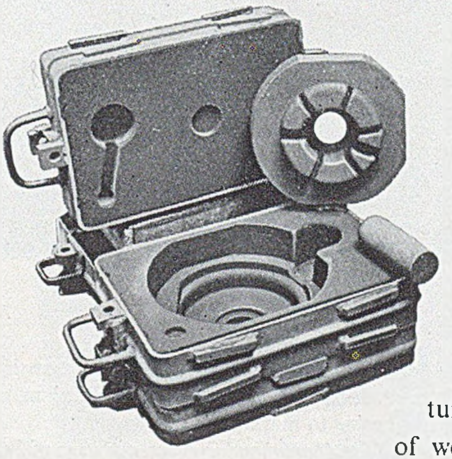
We are greatly indebted to Messrs. Shanks Iron-founders Ltd., Dens Ironworks, Arbroath, for permission to reproduce these photographs, so recently employed in an interesting exposition of resourceful practice.



The photographs reproduced on this page have already appeared in this Journal in illustration of a most interesting paper descriptive of the procedures employed in the production of castings for a small 8 h.p. Diesel Engine.

The joint Authors revealed considerable resource in the use of cover coring for purposes of true location of cores, combined with a technique of pouring the moulds through runners in the cores, resulting in the elimination of turbulence during casting, and marked reduction in the ratio of weight of runner to casting.

Core interiors in work of this character must be as good and sound as the exterior surfaces, and able to resist the erosive action of the Metal in runner passages.

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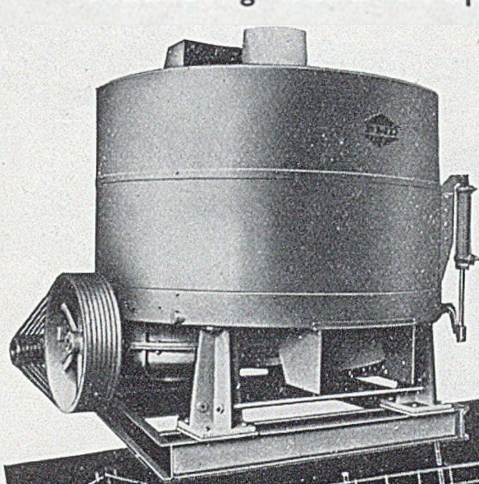

Preparing machines for natural and synthetic sands for batch and continuous operation up to an hourly output of 1430 cu. ft., sand slingers, vibratory knock-out grids, automatic sand-cooling—and dust extracting—installations, iron separators, sifting installations, sand bins, conveyor belts, roller conveyors, circular conveyors and all additional devices, e.g. moulding box pass-over devices and automatic mixing installations for core sand.

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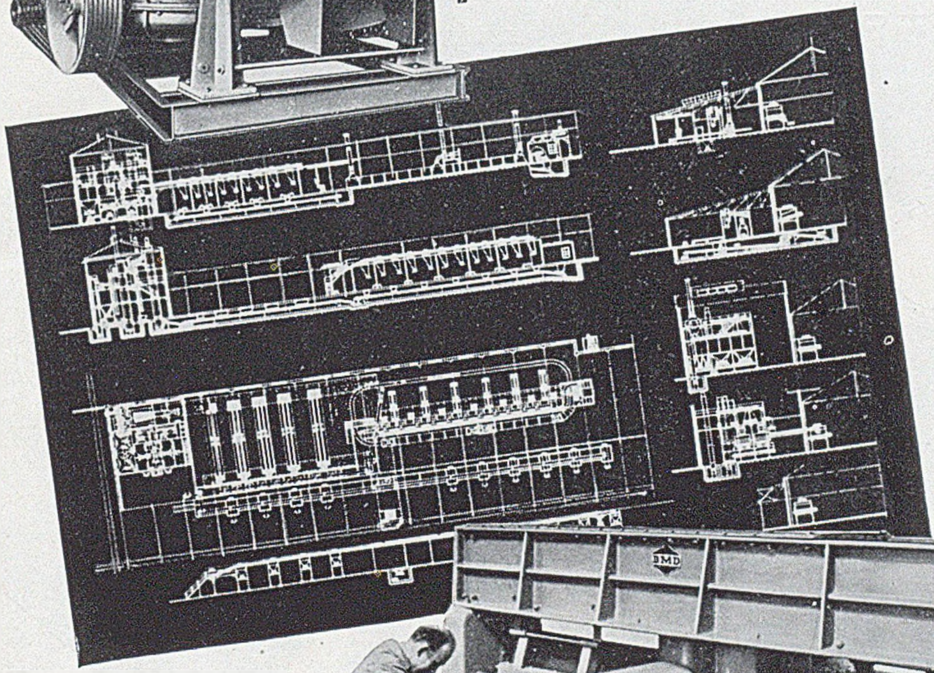

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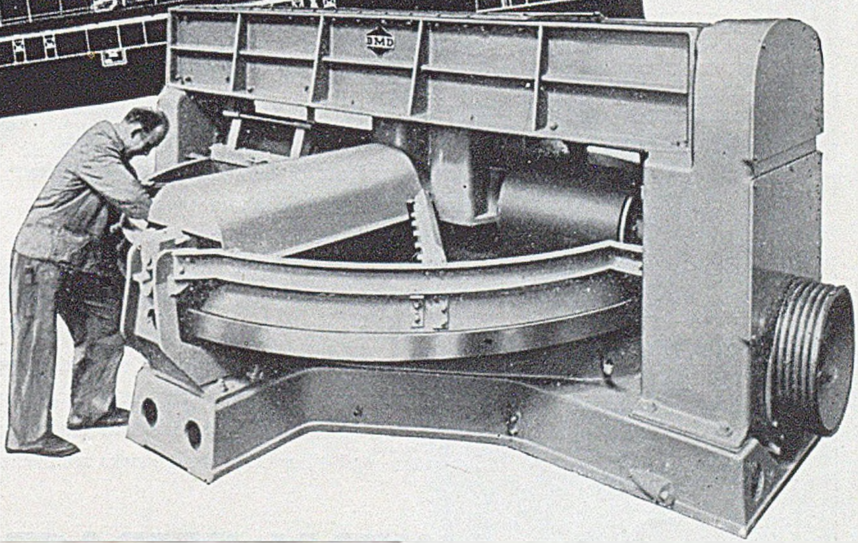

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Illustrated

Larger and smaller machines available

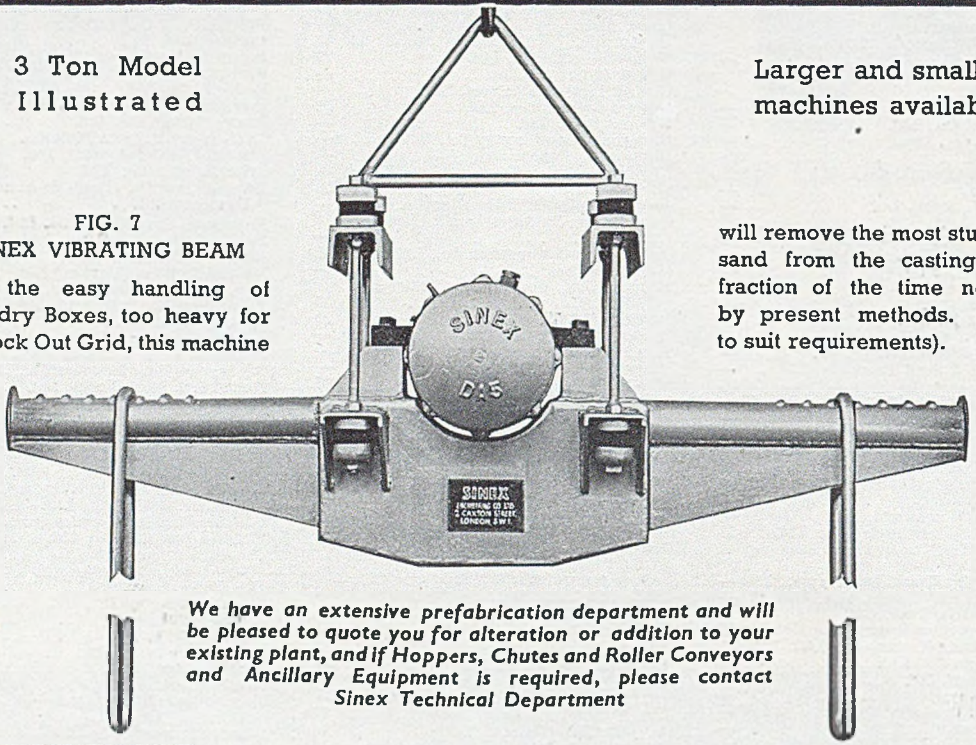

FIG. 7
SINEX VIBRATING BEAM

For the easy handling of Foundry Boxes, too heavy for a Knock Out Grid, this machine will remove the most stubborn sand from the casting, in a fraction of the time needed by present methods. (Links to suit requirements).

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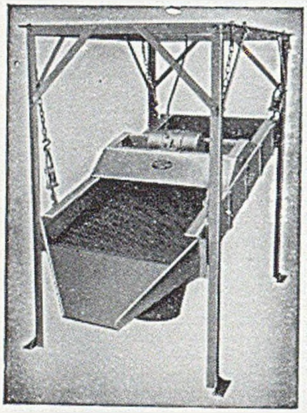
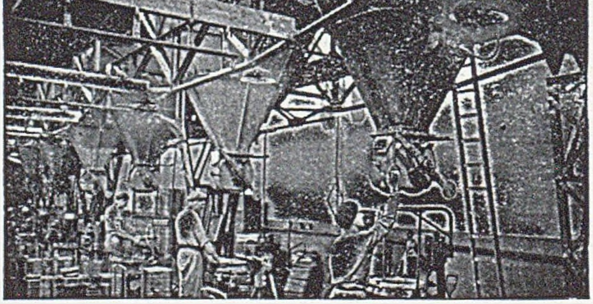


FIG. 10 (on left)

Sinex Vibrating Screen 6ft. × 3ft. Single Deck. Hourly output—15 tons of sand through ⅜ inch mesh.

This screen is also manufactured in sizes to suit requirements.

FIG. 8 (illustrated below)
An important function of Sinex High Frequency Vibrators is the application to Sand and Storage Hoppers. To facilitate the rapid discharge of the material, long experience has shown that the fitting of a Sinex Vibrator to a Hopper containing the most stubborn material will avoid "arching" or "funnelling" of the material in the neck of the Hopper and assure a regular flow. Fig. 8 shows a batch of moulding Sand Hoppers fitted with Sinex Vibrators. These machines are manufactured in various sizes suitable to the capacity of the Hopper, and are wound suitable for any electric supply, single or 3-phase A.C.



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Established 1902
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Time for Reflection

The New Year is a time for reconciliation and not for the opening up of new quarrels. Thus we deem it a matter of real misfortune that some very prominent firms have decided to resign from their employers' association because of their disagreement with the policy of the Council of Ironfoundry Associations in the matter of the Iron and Steel Bill. We grant that firms may regard this as an outstanding current controversy, yet it may temporarily make them forgetful of the fact that negotiation with the Government is but one of the many activities of the C.F.A. We are reasonably sure that the dissident members have no quarrel with the educational, research and the many other activities of the C.F.A.

The foundry industry, which, using as a basis the value of its output and comparing it with the money credited for steel ingots, is of equal importance with the iron and steel industry, obviously must have a body capable of representing its interests. If, as we so often have advised in the past, an employers' federation had been formed to cover the whole of the foundry industry, then its importance would have been so obvious that no authority would have suggested lumping it in with any other industry. By and large, the foundry industry is considered part of the engineering trades when wages are to be discussed whilst the statistics for ironfounding are collected and published by the British Iron and Steel Federation. The foundry industries of both France and Germany are organized as one entity and we would draw attention to a picture published elsewhere in this issue of the "Foundry House" now functioning in Düsseldorf. This building has been built and equipped since the war ended.

Thus we ask the dissident firms to survey the whole work undertaken by the C.F.A. and determine whether by energetic participation they can so orient the conduct of the Association as to conform more to their conceptions of what is required. After all, these associations are democratic bodies, and their only sensible desire being to give service, this conception of service to mean anything must be the intelligent interpretation of members' aspirations and ascertained requirements. Employers' associations are an essential in the present industrial set-up and it is the duty of members by active and energetic participation in the activities to see that their conduct aligns itself with the opinions of the majority—otherwise the executives can only guess. It must not be lost sight of that the organization of the ballot on the subject of the Iron and Steel Bill which has just been taken has required much co-operative action, which stresses the need for the existence of an association to function rapidly in an emergency. Thus, disintegration will not help, but a more intensive interest in association affairs should in the future go far to remove causes of friction. The main theme we wish to stress is not to allow the present controversy to get out of proportion, as there are so very many matters where co-operative action is needed.

Acknowledgments

Greetings cards and gifts of diaries and calendars are gratefully acknowledged from the following, and their good wishes for 1953 are reciprocated:—

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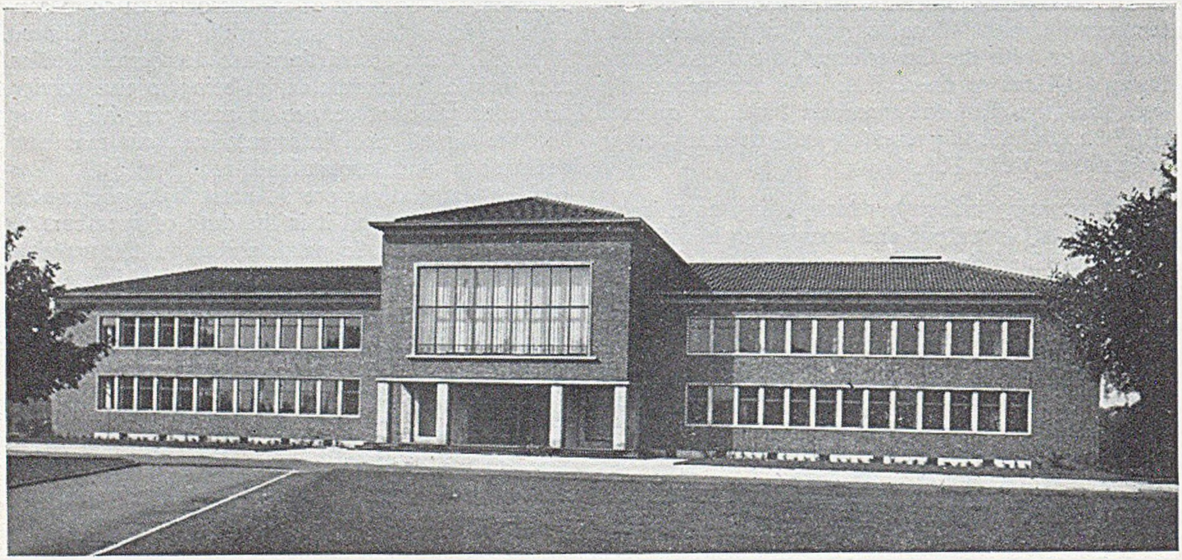
Belfast Ironfounders at Westminster

A deputation of Northern Ireland ironfoundry executives conferred with the Unionist members at Westminster last week They discussed the Iron and Steel Bill at present before Parliament and its inclusive proposal that "tied foundries"—*i.e.* foundries which are part of engineering concerns—should be brought under public supervision. Belfast and Northern Ireland foundry executives object to this proposal on the ground that they would be subjected to irksome controls. The M.P.s will probably assure them that the supervision would be carried out with a light and helpful hand. Further, they will point out that the Minister of Supply has promised to introduce modifications in the Bill so as to remove the doubts and fears of owners of "tied" foundries and also of the group of M.P.s who have threatened to oppose the Bill. Two things appear to be almost certain—first, that British founders will have to accept some form of public supervision, and secondly, that the Northern Ireland Parliament will choose to come in under the Bill when it is passed. It is considered vital that they should do so in order to ensure supplies of materials to the Belfast and Northern Ireland foundries, which would also be liable to benefit from development schemes that the Iron and Steel Bill may initiate.

Director's Long-service Dinner

To honour the 50 years' continuous service of Mr. William S. Bulpitt, the Birmingham firm Bulpitt and Sons, Limited, makers of aluminium and electrical appliances held a dinner and entertainment at the Grand Hotel, Birmingham on January 13. Among the three hundred guests present were Mr. Bulpitt's two sons, Mr. Walter Bulpitt, managing director and Mr. Albert Bulpitt, director, with employees of 15 years' continuous service. The firm was started by Mr. William Bulpitt's father in 1868 and now employs about 1,200 workers in factories in various parts of Birmingham.



View of the Headquarters of the German Foundry Industry. This building, situated in the suburbs of Düsseldorf, has replaced Wooden Hutments, and was opened last year.

Solidification Rate of Cast Iron

Summary of the Report of Sub-committee T.S.33 of the Institute of British Foundrymen

The original Institute work was started in 1947 by sub-committee T.S.21 with the apparently straightforward terms of reference "To study the effect of mould materials on the solidification rate of grey cast iron," under the chairmanship of Mr. L. W. Bolton. The interrupted-freezing or slush-casting method was used by that sub-committee. This consisted of filling a series of three-part cylindrical moulds with molten metal and at predetermined intervals after pouring (usually two to three minutes) the top- and middle-part moulds were jointly lifted away from the bottom mould allowing the metal which was still liquid to flow out, leaving a shell of metal around the periphery of the mould. The thickness of the remaining metal shell was then measured. The result of this work was rather negative, as few data were obtained on the effect of mould materials, due to the difficulty of producing shells above 0.4 in. thick. The inner surfaces of the shells produced were rough and uneven owing to the long freezing range and pasty mode of solidification of cast iron which impeded "bleeding." When high-phosphorus iron was used, this characteristic was reduced but not eliminated. The work was carried out at the Birmingham University's Department of Metallurgy under the supervision of Dr. V. Kondic. In order to overcome this difficulty it was necessary to investigate experimental methods. A new sub-committee (T.S.33) was formed in 1949, and T.S.21 was dissolved, most of its members agreeing to serve on the new committee under the chairmanship of Mr. L. W. Bolton and later of Mr. J. Hird. The following terms of reference were given:—"To explore the suitability of the pyrometric and alternative methods for investigating the rate of solidification of cast iron."

The work of the new sub-committee T.S.33 has concentrated on the pyrometric method, which consists of placing one or more thermocouples in selected positions in the mould cavity or moulding sand or both, and recording the temperature changes from the moment of pouring the metal into the mould until solidification occurs, with a fast (one-second response) temperature recorder or a high-speed galvanometer.

Fig. 1 shows the general layout of the equipment for these experiments when casting plates up to 2½ in. thick with the thermocouple in the casting, while Fig. 2 indicates the layout for 3-in. thick plates with the thermocouples in the sand as well as in the casting.

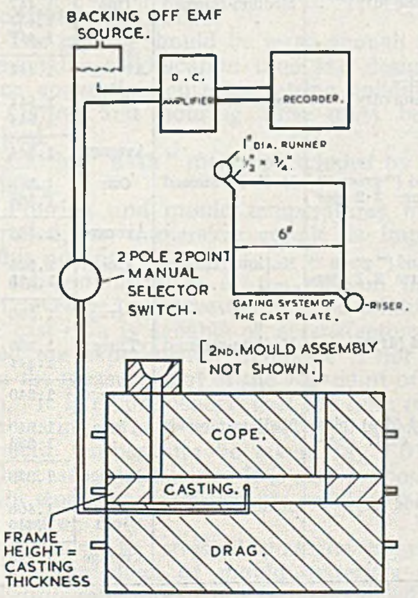


FIG. 1.—*General Layout—for Casting Plates up to 2½ in. thick in the Solidification Experiment.*

The first series of experiments using this method and hand ramming the moulds to a known mould hardness figure, gave results which had poor reproducibility and were somewhat disappointing. However, two important conclusions were drawn which later proved to be correct. The first was that mould density was of paramount importance. (It was later shown that this can have as great an effect on the solidification times as changes in the grade of

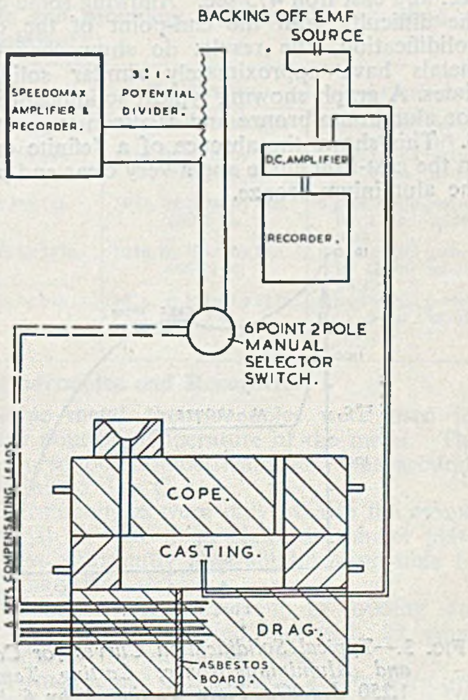


FIG. 2.—*General Layout of Apparatus for the 3-in. Block Solidification Experiments.*

moulding sand). The second conclusion was that it was not possible to find the exact point of solidification of cast iron owing to its long freezing range—the cause of the difficulty that contributed to the failure of the slush-casting experiments.

Modified Method

It was then decided to modify the method of the experiments to eliminate as far as possible these two possible causes of unreproducibility. The moulds were now rammed by squeezing a weighed amount of sand into the moulding boxes on a moulding machine. Checks showed that mould hardness varied little over the cross-section of the mould, though the corners tended to be softer. After ramming, the weights of the moulds were checked and the moulds were remade if the results differed by more than 2 oz. After drying at from 200 to 300 deg. C. for six hours and cooling to room temperature, the moulds were cast with eutectic (8 per cent.) aluminium-bronze, the pouring temperature being 1,250 deg. C. The melting point of the alloy is 1,038 deg. C. and the superheat corresponds roughly to to the heat content of cast iron cast with about 100 deg. superheat.

In order to compare the solidification times of aluminium bronze with that of cast iron, two moulds of a 1-in. thick plate were made using fine sand. One was cast with aluminium-bronze at 1,250 deg. C. and one with cast iron at 1,250 deg. C. The aluminium-bronze gave a solidification time of 430 sec. and cast iron 475 sec. Allowing some error for the difficulty with the end-point of the cast-iron solidification, the results do show that the two metals have approximately similar solidification times. A graph showing typical solidification curves for aluminium-bronze and cast iron is given in Fig. 3. This shows the absence of a definite end-point in the cast-iron curve and a very clear end-point for the aluminium-bronze.

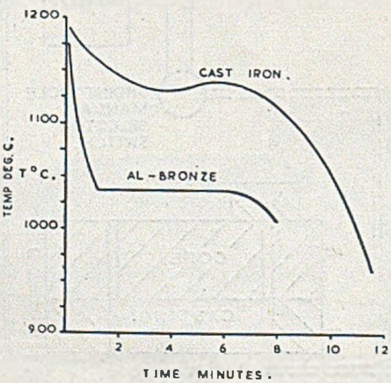


FIG. 3.—*Typical Solidification Curves for Cast Iron and Aluminium-bronze; Casting Temperature 1,250 deg. C.; Plate Casting 1 by 6 by 6 in.; Fine, dry Sand having a Density of 1.36 gm. per cc.*

Second Series

A second series of experiments was then carried out using the modified method, and results from these, given in Table 1, show much better reproducibility and the varying densities of the moulds used for the 1-in. thick plates emphasize the effect of density on solidification times. The higher the density in a particular sand used, the greater the chilling power (cooling capacity is referred to as chilling power throughout this report). This statement should not, however, be generalized.

TABLE I.—*Times of Total Solidification of 6 by 6 in. Plates Cast in Aluminium-bronze.*

Sand.	Kind of mould.	Plate thickness (inches).	Mould density.	Solidification time (secs.).
Bromsgrove (dry) ..	Medium-rammed	One	1.395	378
			1.390	396
		Average	1.392	387
Bromsgrove (dry) .. (plus 8 per cent. coal-dust)	Medium-rammed	One	1.381	336
			1.377	324
		Average	1.379	330
Fine sand (dry) ..	Soft-rammed ..	One	1.167	449
			1.175	445
			1.175	437
		Average	1.172	444
Fine sand (dry) ..	Medium-rammed	One	1.351	391
			1.355	392
			1.355	393
			1.355	399
			1.360	377
			1.363	388
		Average	1.356	390
Fine sand (dry) ..	Hard-rammed ..	One	1.417	354
			1.425	352
			1.430	354
		Average	1.424	353
Coarse sand (dry) ..	Medium-rammed	One	1.447	307
			1.447	291
			1.447	289
		Average	1.447	296
Coarse sand (dry) ..	Hard-rammed ..	One	1.544	288
			1.544	306
		Average	1.544	297
Find sand ("green") (moisture 3·2 per cent.)	Medium-rammed	One	1.368	330
			1.368	315
		Average	1.368	322
Coarse sand ("green") (moisture 2.1 per cent.)	Medium-rammed	One	1.526	270
			1.535	296
		Average	1.530	283
Fine sand (dry) ..	Medium-rammed	Three	1.336	1,080
			1.344	1,095
		Average	1.340	1,087
Fine sand (dry) (plus 8 per cent. coal-dust)	Medium-rammed	Three	1.340	912
			1.336	1,002
		Average	1.338	957
Coarse sand (dry) ..	Medium-rammed	Three	1.406	828
			1.446	996
		Average	1.426	912

Although the statement is probably true for most moulding sands, it is possible that there are moulding materials which would not conform to the rule. Carbon additions (coal-dust) also increase the chilling power and coarse sand appears to have chilling power almost equal to fine sand plus coal-dust.

Theoretical Method Explored

The sub-committee also investigated a theoretical method of comparing the chilling power of different mould materials based on the laws of heat-transfer and developed by Chvorinoff (Iron and Steel Institute, translation No. 117, 1943) and Ruddle, (J. Inst. Metals 1949, 76, (1) 43). It consists of determining a series of time/temperature curves by means of thermocouples located in the moulding material at various distances from the interface. (It was found that this was only practicable on 3-in. thick plates, as thinner plates had too short a solidification time). From such curves the thermal diffusivity of the moulding material can be calculated. The accuracy of the method depends on the accuracy of the measurement of the distance between the interface and the thermocouples and on the uniformity of ramming. A certain mathematical skill is required for the evaluation of the results, but once obtained, the chilling power in absolute units can be calculated.

Interpretation

In the method developed by the sub-committee, the results are comparative only and for conversion into absolute units the chilling power of one of the mould materials investigated must be known. However, the method so developed using only a stopwatch, thermocouple and galvanometer by way of special apparatus, and without specially-skilled investigators, gives results which accurately compare the chilling power of different moulding materials under a variety of conditions, providing that the following precautions are rigidly observed:—

1. Sand bulk-density and moisture content to be accurately controlled.
2. The casting should be large enough to give a reasonable solidification time and designed to reduce convection currents during solidification.
3. Gating and pouring time must be standardized.
4. Casting "flash" must be excluded by careful moulding.
5. Pouring and mould temperatures must be controlled; an immersion couple is imperative for this purpose.

The sub-committtee is of the opinion that the method developed for investigating the solidification rate of cast iron is capable of a satisfactory result provided the experimental technique is not dependent on the measurement of the end-point of solidification. It is recommended that the time required for the casting to cool to an arbitrary point below the eutectic temperature be taken, say 1,050 deg. C. in the case of cast iron. It is also proposed that in future work time/temperature readings be taken in the casting only.

It must also be stressed that the conclusions drawn on the effect of mould materials on the solidification rate should not be generalized or indeed accepted for other than the experimental conditions used until further work has been carried out to prove them and to put the conclusions in their correct perspective.

The Technical Council is now of the opinion that the sub-committee has completed its work within its terms of reference and T.S.33 is being disbanded and a new sub-committee, T.S.46, has been formed. Most of the members of T.S.33 will serve on the new committee which has the following terms of reference:—

"To investigate the effect of mould materials on the cooling rate in the solidification range of cast metals, with particular reference to cast iron."

APPENDIX

Equipment and Material used

(1) Grading of sands:

B.S. sieve number.	Bromsgrove (washed).	Arnolds 26A fine sand.	Arnolds 2A coarse sand.
Plus 12	0	0	1
,, 18	0	0	3
,, 30	2	0	53
,, 46	6	1	40
,, 60	23	6	3
,, 100	42	53	0
,, 150	18	33	0
,, 200	6	5	0
Minus 200	3	2	0

The Bromsgrove sand contained 11 per cent. clay, and 3½ per cent. bentonite was added to the synthetic sands.

Black sand consisted of 8 per cent. superfine coal dust added to above sands as indicated in Table 1.

(2) Plate and moulding box sizes and method of moulding:

Plate.	Moulding box.	Method of moulding.
6 in. by 6 in. by ¼ in.	10 in. by 10 in. by 3 in.	2-part mould pattern in bottom part.
6 in. by 6 in. by ½ in.	10 in. by 10 in. by 3 in. and ½ in.	3-part mould pattern in ½ in. middle part.
6 in. by 6 in. by 1 in.	10 in. by 10 in. by 3 in. and 1 in.	3-part mould pattern in 1 in. middle part.
6 in. by 6 in. by 1½ in.	10 in. by 10 in. by 3 in. and 1½ in.	3-part mould pattern in 1½ in. middle part.
6 in. by 6 in. by 3 in.	12 in. by 12 in. by 3½ in. and 3 in.	3-part mould pattern in 3 in. middle part.

(3) Thermocouples and Recorders:

(*a*) Noble metal thermocouples were used for taking the pouring temperature of the metal. This was measured potentiometrically and was accurate to plus-minus 5 deg. C.

(*b*) Thermocouples were only used in the moulding material on 3-in. thick plates as thinner plates do not give sufficiently long solidification time for thermal analysis.

(*c*) Temperature measurement in casting and mould material was carried out with 28 gauge chromel-alumel thermocouple wire.

(*d*) Thermocouples in the mould cavity were protected with thin refractory sheathing, except the hot junction end, which was lightly coated with a thin alumina wash over a length of ½ in.

Solidification Rate of Cast Iron

(*e*) Thermocouples inserted in the mould material were protected either with a strong refractory or metallic sheathing (Pyrotenax) except for the last ½ in. which was left bare.

(*f*) *Recorders*:

For temperature changes in the casting, a Tinsley recorder was used. For temperature changes in the moulding material a Speedomax high-speed recorder was used. The response of these recorders is of the order of one second for the full scale of the temperature chart, which can be adjusted to correspond to full-scale deflection of 2-20 or 45 m.v. In this way different sensitivities of temperature recordings can be obtained accurately to plus-minus 2 deg. C.

(4) Metal:

(*a*) Cast iron analysis 3.2 per cent. T.C., 2.16 per cent. Si., 0.9 per cent. Mn., 0.12 per cent. P., 0.09 per cent. Su. Half furnace charge virgin ingot and half remelt metal.

(*b*) Melting for plates up to 1 in. thick was in a high-frequency furnace. Over 1 in. thick, single-phase arc furnace.

(*c*) Pouring temperature 1,250 deg. C. unless otherwise stated.

(*d*) Aluminium bronze. Eutectic 8 per cent. aluminium melted in a crucible gas-fired furnace, no flux being added.

(*e*) Pouring temperature of aluminium bronze was 1,250 deg C. but was superheated to 1,350 deg. C. and cast at 1,250 deg. C.

Lectures on Mould Materials

A course of six weekly lectures on Mould Materials to be given by members of the staff, has been organized by the National Foundry College and will be held at the Wolverhampton and Staffordshire Technical College, on Thursdays, at 6.30 p.m., commencing February 12. The individual lectures are, consecutively, "Moulding Sands" (introductory) by W. Prentice, B.Sc., M.Inst.F., A.I.M., covering (*a*) natural sands; origin, composition, impurities, applications; (*b*) synthetic sands: (i) silica sands—origin, composition, and grading and (ii) clays; "Additions to Mould Materials" by S. N. Wrightson, B.Ss., A.I.Mech.E.; "Sand Tests and Testing" by J. Bamford, B.Sc.; "Core-bonding Materials" and "Recent Developments" both by J. B. McIntyre, M.Sc. A.I.M., and "Casting Defects due to Mould Materials" by J. Bamford, B.Sc. Full opportunity will be given for questions and discussion at the end of each lecture.

The course is designed for foundry foremen and managers and other executives responsible for the quality and economical production of castings. Enrolments should be made as soon as possible, either by post or at the enquiry office of the Wolverhampton and Staffordshire Technical College. Entries will, however, be accepted, if places are still available, up to 6.15 p.m. on the first night. The fee is £2 and further particulars may be obtained from the Head of the National Foundry College.

Correspondence

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

IRON AND STEEL BILL

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—There are so many misconceptions in Mr. Crabtree's letter (published in your issue of January 1) that I had better try to deal only with the principal ones. In the first place, Mr. Crabtree is assuming that Mr. Newman and the Council of Ironfoundry Associations, are one and the same entity. In so far as this is a compliment to Mr. Newman's chairmanship, I applaud Mr. Crabtree's good sense. Unfortunately, however, Mr. Crabtree makes it very clear that he is criticizing Mr. Newman as an individual and as a chairman. No one who has been well acquainted with the events of the past year could possibly let this pass unchallenged.

On every occasion on which Mr. Newman has had to speak for the C.F.A. he has consulted the C.F.A. committees. He has, without exception, been guided by majority rulings. Thus, Mr. Newman's behaviour as a chairman has been strictly constitutional. Those of us who have been privileged to sit under his chairmanship have been impressed not only by his scrupulous fairness and correctness and his grasp of facts, but also by the manner in which he has gone out of his way to meet the wishes of the minority.

As far as the C.F.A. representatives themselves are concerned, these too, have done everything possible to ascertain the views of the committees and members for whom they have had to speak. In every locality, the Bill has been debated by members and executive members at great length and I would add that possibly more literature has been circulated on the subject than the average individual member has felt inclined to digest. If Mr. Newman or the C.F.A., or its constituents, had behaved in any manner other than constitutional, then there would have been good grounds for criticism, but it seems extraordinary that Mr. Crabtree should be objecting that views have been ascertained in a constitutional manner and that the majority will has prevailed. This behaviour is in marked contrast to that of the minority who have used every means, both fair and foul, to get their own way. They have not hesitated to draw into a conflict of views on ironfounding a host of influential engineers and other organizations to confuse an issue which is strictly an ironfounding issue.

It would be pointless at this stage to debate, as Mr. Crabtree does, the *pros* and *cons* of the inclusion of ironfounding in the Bill. If any evidence was really needed to show that the majority who gave rise to C.F.A. policy had acted wisely, that evidence is now to hand in the C.F.A. circular of January 2.

As a result of the C.F.A.'s policy under Mr. Newman's skilled spokesmanship, it is clear that, as far as ironfounding is concerned, the Bill is going to be amended in such a way that we remain in the Bill for all the benefits, with positive exemption from all its trying obligations. As amended, the Bill will secure for ironfounders their raw materials and their research grants and will omit price control, development control and "snooping." Whether this contents Mr. Crabtree or not, I would suggest that the least he can do is to publish a statement that in speaking as he did of Mr. Newman, he was really criticizing a majority and not an individual.—Yours, etc.,

T. LEE, President.

National Ironfounding Employers' Federation.

January 6. 1953.

* See article on page 83.

Principles of Gating . . . . .

. . . . Review and Bibliography of Previous Investigations

By G. Martin, B.Sc.

*The subject of the gating of castings has received much attention in foundry literature, as it is one of the main factors affecting both the soundness of the casting and the economy of the casting process. In view of the importance of the subject, it is surprising to note that until fairly recently only a very few investigations have dealt with the subject systematically and attempted to derive fundamental principles. Most of the investigators of the problem contented themselves with stating that for a particular casting in a specific metal a particular gating system was found the most satisfactory. A wealth of practical information of this sort is summarized in a book[1] by Dwyer, who, however, also does not enter into the principles underlying the various systems. It is therefore proposed to deal in this review only with attempts which have been made to investigate basic principles. The main function of a gating system is to introduce molten metal into a mould cavity in a certain time, with a controlled turbulence and pattern of flow. Investigations therefore can be grouped into those studying turbulence effects and those concerned with the rate of flow through the gating system in relation to its dimensions.**

STUDIES OF TURBULENCE EFFECTS

Four main methods have been utilized for gating studies: I. *Transparent mould models,* using water or mercury as the liquid. The use of this method is based on the law of similarity of flow-pattern of different fluids flowing through a given channel with equal velocity and having the same kinematic viscosity. The usual mould material is Perspex, though, glass-plate-covered plaster-of-Paris moulds have also been used.[2] The liquids used are: water, with the same kinematic viscosity as aluminium, water/glycerine mixtures,[3] mercury or Wood's alloy. Dross was represented in one case by particles of vulcanized resin of a density of 0.98 and a particle size of 1.5 mm.[3]

Such methods have the advantage of simple and cheap construction and not only can aspects of flow be recorded continuously by means of a ciné camera, but instruments recording such data as gas pressure, etc., can also be incorporated. The main difference as compared with actual casting lies in the absence of heat-flow effects and the very much greater difference in the surface tension and density of metals and water. The use of mercury or Wood's alloy, of course, obscures flow phenomena inside the liquid body.

In addition to that of the investigators quoted, this method has also been used in the very systematic work of Swift, Jackson and Eastwood[4] and Grube and Eastwood[5] (who checked the results obtained on their flow models with actual castings of magnesium alloy), and the work of Elliott and Mezoff.[6] Silvestro[7] describes a patented method of studying flow in Perspex moulds, using mercury, and comments on the great value of such flow-studies in gating design.

II. *Direct observation of the flow of molten metals in moulds.*—This method has been widely used. In the U.S.A., Johnson and Baker,[8] Johnson, Baker and Pellini,[9] and Johnson, Bishop and Pellini[10] investigated the flow of steel in sand moulds, using both normal and special high-speed ciné equipment as recording apparatus. In Great Britain, investigations on cast iron seem more popular, work having been published by Harding[11] and the Institute of British Foundrymen.[12] In the case of ingot casting, much can be observed directly and Kerlie[13] describes the depression of the metal level in the trumpet and cascade effects in the ingot mould on up-cast ingots. The type of surface movement and flow pattern inside the casting have been correlated by Pellini and co-workers. However, this method of observation is essentially two-dimensional and difficult to apply to complex casting shapes.

III. *Observation of metal flow by means of X-ray ciné study.*—This method has been used in one investigation only. Fry,[14] using a narrow sand mould and casting aluminium, was able to take ciné films of the fluorescent screen placed behind the mould during casting. Schaaf[15] reports that an X-ray flash tube can be used in lieu of an ordinary X-ray tube to make short-time exposures of the flow of molten metal, but does not seem to have applied his method to the problem systematically. Theoretically, this method is ideal, as it permits the observation of the flow-pattern inside a mould under ordinary casting conditions. In practice, it is limited by the penetration power of the X-ray set available and the fluctuation of the radiation emitted due to A.C. fluctuations in the power supply.

IV. *Use of tracers in the liquid stream.*—Various combinations of different tracer methods have been used. Northcott[16] used the study of segregation and crystal growth of steel ingots cast by different processes, checking his results by "casting" water containing a suspension of tea-leaves. The standard hydraulic method used to show up flow-pattern in transparent liquids is by the use of a suspension of aluminium powder or dye. Genders[17] poured portions of ingots in an alloy of 90 per cent. copper and 10 per cent. zinc, completing the cast with an alloy composed of 50 per cent. copper, 30 per cent. zinc and 20 per cent. nickel. On sectioning the solidified ingot, the two alloys formed layers easily distinguishable by their colour. The use of radioactive tracer

* A brief glossary of the hydraulic terms used will be found in Appendix "A."

elements has been suggested by Johnstone.[18] Temperature-distribution measurements in a casting before its solidification allows some deductions to be made as to the probable flow-pattern. Such temperature measurements are greatly affected by convection currents and in any case require the availability of a high-speed recording instrument Some results are given by Reichert[19] and Sefing.[20] Tracer methods used in castings suffer from the disadvantage that they allow only the flow-pattern existing just prior to solidification to be determined.

Experimental Results

Qualitatively, the results reported confirm facts already known to many foundrymen, but some interesting additional information is given. These results can be summarized as follow:—

(i) The kinetic energy possessed by the jet of liquid metal emerging from the ingate is such that, in the case of castings of a simple shape, this jet penetrates the entire body of liquid already in the mould. This applies both to top and bottom gating and results in a double vortex current in the casting cavity.

(ii) Direct top-gating or top side-gating invariably results in considerable agitation of the surface of the molten metal. In the case of bottom gating, this surface turbulence is confined to the beginning of the casting operation. Once a back pressure has been built up in the mould, whether caused by the weight of metal or insufficient venting, this turbulence is reduced.

(iii) Flow into the mould through several ingates was investigated in great detail by Pellini and coworkers. Generally, all ingates will feed evenly only under certain critical conditions, determined by the shape and dimensions of the entire gating system. Even feeding occurs if the excess kinetic energy contained in the metal stream is distributed or absorbed by the runner bar. This can be achieved either by branching ingates backwards at an angle of more than 90 deg. to the direction of flow or using runner bars of special shape. In the case of step-gating, it may even occur that the metal already in the mould flows back into the runner through the top ingate. For even feeding, it is also essential to have the choking section, *i.e.* the section of the gating system having the least area, at the ingate. Choking at any other point in the system is useless from the point of view of even feeding. An excessive choke, however, at the casting end of the ingate may result in a jet-like spurt of metal which causes erosion damage.

(iv) Sharp bends in the gating system increase turbulence substantially, and streamlining of the gating channels, particularly at the bottom of the down-runner and at the ingate branches, reduces turbulence.

(v) Under certain conditions, air is aspirated into the down-runner. Air thus aspirated or air sucked into the down-runner by a vortex formed in the pouring basin aggravates turbulence. Air pockets can be formed behind sharp corners in the gating channels and can cause obstructions of the flow, though such air pockets are usually swept into the mould after a few seconds.

(vi) Increased turbulence in the down-runner causes the transport of increased dross into the casting. Whether laminar flow eliminates the transport of dross could not be ascertained as the transition point from laminar to turbulent flow in a channel of the complexity of a gating system has never been determined with certainty. Most authors assume the transition point to occur at a Reynolds number of about 2300, the value generally accepted for a straight, round tube. In fact, the lower critical limit can occur from as high a Reynolds number as 8000 in bends, to as low a number as 15. Johnson and Baker observed that a jet of liquid steel emerging freely from a vertical nozzle is turbulent at first and later becomes streamlined in appearance, though still varying in thickness along its length. This seems to indicate the existence of a surface film rather than laminar flow.

(vii) Convection currents exist in the metal and may effect flow and crystal growth phenomena, as shown by Northcott[16] and Sokolskaya.[21] In a simple casting, which is cooling from the liquid stage, such currents are reported to run down the centre and up the walls.

(viii) No work has been published so far on the flow of metal in a complex cored casting, though the construction of appropriate models should present no great difficulty.

Conclusions on Turbulence

Quantitatively at least, it is possible to predict the the manner and pattern of flow from a given gating system into a simple casting and to make some conclusions as to the degree of turbulence likely to occur in the casting and the gating system. As to the problem of dross transport, experimental evidence shows that the less turbulence there is in the gating system the less dross is likely to be carried into the mould. It is unlikely that in general casting practice truly laminar flow is ever achieved, except perhaps in very narrow pencil gates or on a narrow, smooth bend.

FLOW THROUGH A GATING SYSTEM

Development of a gating formula

Although the basic laws of hydraulics have been established for about 150 years, their application to the study of the flow of metals in castings has only been carried out very recently and apparently independently in this country, the U.S.A., Poland, Czechoslovakia and Germany. This appears to be mainly due to the fact that most of the early investigators were not sufficiently familiar with hydraulics and tried a more or less haphazard application of a new simple formulae. Or they have, from their own practical experience, built up an empirical equation, which later proved to be limited to one particular type of casting practice only.

Two basic assumptions have to be made before hydraulics can be applied to gating problems. The first is that all metal cast remains liquid until casting is completed and the second one is that liquid metals behave like true liquids. Whilst the first assumption is self-evident, inasmuch as it is the basis of the casting process, the second is more difficult to prove and only very recent work has shown it to be correct.

The first investigations of the problem were published by Dietert[22] in 1926, who from practical experience established the law

$$\text{casting rate } Q = k_1 \sqrt{\text{Casting weight}}$$

where k_1 is a constant depending on the thickness of the section cast. The total ingate area is then found from the apparently empirical formula

$$\text{total ingate area} = k_2 \sqrt{\text{Casting weight}} / \sqrt{H}$$

where H is the effective head given by the equation $H = (2Ch - G^2)/2C$, where

h is the height from the ingate to the top of the mould,
G is the height of the casting above the gate, and
C is the total height of the casting.

The same author in a later paper[23] gives a more detailed list of the constants used for iron:

If casting weight in lb., the value is of	k_1	k_2
For sections of thickness 7/64 to 9/64 in.	1.1	0.28
For sections of thickness 10/64 to 20/64 in.	1.25	0.32
For sections of thickness 21/64 to 39/64 in.	1.5	0.38

Petin[24, 25] modified Toricelli's formula to

$$v = \sqrt{2g\,(H \pm 0.5\,L)}$$

where H is the distance from the ingate to the top of the mould and C the height of the casting, being added in case of top pouring and subtracted for bottom pouring. Graphs are given of the relation of down-runner area and rate of flow for various gating methods, from which he calculated the overall loss-coefficient, k. The down-runner area is then found from:—

$$\text{Area} = Q/k \sqrt{2gH \pm 0.5C}$$

k was found to vary from 0.15 to 0.78.

In the same paper, Petin also worked out the maximum quantity of cast iron that could be delivered by various types of ladles. These vary from 4.2 to 11.2 lb. per sec. for 56 lb. hand ladles and 11.4 to 23.7 lb. per sec. for 1 ton crane ladles. These values agree roughly with some pouring rates given later by Silvestro, who quotes a rate of 15 lb. per sec. for a crane ladle poured over the lip and 40 to 75 lb. per sec. for ladles teeming through a bottom nozzle. For aluminium, Howarth[26] suggests a casting rate of 4 to 8 lb. per sec. for small castings and 15 lb. per sec. for large castings.

The simplicity of the Toricelli equation has tempted several investigators into using it as a basis for a general gating equation, accounting for different casting methods and types of casting by the use of empirically determined coefficients. Such equations are given by the following investigators. Stone[27] gives for the ingate area

$$A_1 = 0.13 \sqrt{\frac{W}{H}}$$

where W is the casting weight in lb. and H is the effective head as given by the Dietert equation. Lehmann[28] works out elaborate tables for the dimensions of gating systems of various dimensions based on that formula. He suggests a casting time of 1 to 3 sec. per litre of cast iron for heavy sections, and 3 to 5 sec. per litre for thin sections. The total ingate area is then computed from

$$\text{Area} = Q/k \,.\, \sqrt{2g\,H}$$

where H is, presumably, the total head and k a factor equal to 0.922 for aluminium, 0.866 for cast iron, and 0.837 for steel. Benkoe[29] uses a similar formula, but arrives at the constant by comparing the viscosity of water and aluminium. As the orifice loss-coefficient for water is about 0.62 and the viscosity of aluminium approximately half that of water, he concludes that the loss-coefficient for aluminium is 0.31, a conclusion which is quite erroneous. Osann,[30] like Petin, modifies Toricelli's formula by a factor varying from 0.15 to 0.9. Even more-empirical formulae which cannot claim any scientific foundation are suggested by Henon[31] and by Frede.[32] The latter claims that the rate of flow is controlled by the dimensions of the downgate only. Henon plotted a summary of casting times for various types and weights of castings, utilizing results of some previous authors, and suggests the empirical equation for the total ingate area:—

$$\text{Area} = k_t\,W/k\,H$$

where W is the casting weight in kg, and H the casting height in mm. The values of k_t vary from 8 to 100 for casting thicknesses from 4 cm. down to 1.5 mm. and the constant k is 1.5 for high-phosphorus cast iron, 1.4 for hematite iron, and 1.2 for low-carbon cast iron. In a publication of the Tin Research Institute,[57] the rate of bronze cast through a tun-dish is related to the diameter of the holes in the tun-dish only.

Hydraulic Basis

The first analysis of the overall loss-coefficient on a hydraulic basis was carried out by Miaskowski,[33] whose paper does not seem to have received the attention it deserves. He considered any gating system to be composed of various geometrically simple components and worked out the total friction losses as a sum of the individual losses at these various components. He used the following loss-factors, determined by the flow of water:

Wall-friction loss-factor, $k_1 = 0.03$ L/D ; loss-factor at bend angle α, $k_2 = 0.9457 \sin^2\alpha + 2{\cdot}047 \sin^4\alpha$, which for α of 30, 60 and 90 deg., gives k_2 0.073, 0.364 and 0.984 respectively.

For the loss-factor at down-runner entry (K), no figure was given. Using Bernoulli's equation, the author obtains:

$$h = \frac{V^2}{2g}\,(1 + k_1 + k_2)$$

and further: $Q = K\,a\,v$.

Where V is the velocity, a, the ingate area, and K, a constant, the author obtains

$$Q = K\,a\,\sqrt{2gh}/\sqrt{(1 + k_1 + k_2)}$$

Principles of Gating

Working out the values for $K\sqrt{2g}/.\sqrt{1 + k_1 + k_2}$ for various lengths and diameters of runner, Miaskowski finds this value to be on the average 0.64, varying from 0.6 to 0.67. The use of the Bernoulli equation, as applied in this case, implies that top pouring only is considered. The author quotes experiments with cast iron and aluminium confirming the loss coefficients obtained theoretically. Miaskowski suggests further, from practical experience, the adoption of a down-runner taper of 5 deg. A similar theory was suggested by Lips,[34] who, however, does not seem to have obtained any experimental verification.

Lips and Nipper[35] calculated the effective head for top and bottom pouring, arriving at Dietert's formula. They also collected a list of loss-coefficients applying to the flow of water, without, however, entering into a discussion of their application. The casting time is given as a linear relation of the volume/surface ratio of the casting, the actual slope of the graph depending on the mould used. Casting rates are given as from 33 lb. per sec. for small castings to 440 lb. per sec. for a large roll. Doliwa,[36] after some general discussion of the casting time, gives a head loss at bends of 30 per cent.

Ingates Required

Empirical investigations on the number of ingates required have been made by Janko,[37] who relates this number to the diameter of the casting and gives the following figures:

Dia. of casting ..	12 in.	18 in.	24 in.	30 in.	40 in.
No. of ingates ..	2	3	4	5	6

All investigations so far have attempted to calculate the total ingate area required to fill a casting in a given time. Experiments on turbulence, mentioned earlier, have established that, in the case of a casting fed through several ingates, these ingates do not fill evenly and some of them carry more molten metal than others. It is possible from hydraulic principles to calculate the amount of metal carried into the mould by each ingate—at least for the case where all ingates are on the same level. This calculation was carried out by Berger and Locke,[38] who also verified the results experimentally and report good agreement between theory and practice.

The general state of affairs up to 1949 was reviewed in a booklet by Diepschlag,[55] who also enters into a general discussion of the hydraulic principles involved, arriving at the same conclusions as Miaskowski. A wide and accurate experimental survey of the problem of the rate of flow of metals in gating channels was carried out in Japan by Igarashi and Ohira,[39, 40] who, using a high-resistance wire along the gating system and measuring variations of resistance with a bridge circuit incorporating a Brownian tube recorded by a camera, made accurate and direct measurements of the speed of flow of aluminium in sand casting. Their experimental results were as follow:

Moisture in the sand and casting temperature had very little effect on the casting time. Runner cross-sectional area reduced the speed of flow if below 1 sq. cm., otherwise had no effect. From a table given on the velocities before and after a bend in the runner it was possible to calculate the hydraulic loss-coefficient. Given the angle of the bend, the speed of flow after the bend V_B and the speed in a straight runner V, then, as the external pressure and the static head were equal before and after the bend, and wall friction in the very short section tested could be neglected:

$$\frac{V^2}{2g} = \frac{V_B^2}{2g}(1 + k)$$

From the author's table, the loss-coefficient k at the bend can be computed, obtaining

Bend of ..	0	30	45	60	90	120	135	deg.
V ..	102	95	95	86	62	62	58	cm per sec.
k ..	—	156	156	416	1,588	1,688	2,077	$\times 10^{-3}$

The speed of flow through the various components is also given for a variety of two-branch, three-branch and four-branch runners in multi-ingate systems, but it is not possible to calculate the hydraulic loss-coefficients, as the runners terminate in risers only and not into a mould cavity. Liquid metal flow is therefore stopped at the end of the branch and forced into another channel. Separate experiments were carried out with multi-ingate systems to determine the percentage of metal carried by each ingate, but here again no general quantitative conclusions can be made as the runs were not timed. The qualitative conclusions agree with the results of Johnson and Baker. There appears to be no change in the ratio of the amounts of metal carried by each ingate with variations of the total head.

Investigating the effect of down-runner length on the rate of flow with a down-runner of 4.5 sq. cm. sectional area, they noted a linear decrease of casting time with increasing length of down-runner up to a length of 60 cm., greater length having no further effect. From the mean rate of flow observed, and a head chosen arbitrarily at 4.5 cm. (1 cm. below the down-runner entry), the authors calculated the loss-coefficient for different down-gate lengths from

$$Q = K\,a\,v = K \times 4.5 \text{ sq. cm.} \times 2g\,4.5$$

and obtained values from 0.54 to 0.84 for K for length of 6 to 85 cm. If, however, the down-gate length *does* affect the rate of flow as stated by the authors, then the velocity of flow ought to have been calculated using as effective head the sum of the head in the basin plus the down-runner length.

Using the authors' values for down-runner length L, the head in the basin = 3.5 cm. and the down-runner area as 4.5 sq. cm., the values of K work out as from 0.367 to 0.196 for increasing values of L. As it is unlikely that the total losses in the down-runner represent as much as 63.3 to 80.4 per cent., the whole down-runner length cannot have been effective in affecting flow as stated by the authors. If, however, the head in the pouring basin be considered the only effective head, the loss-coefficient works out at 0.59 to 0.964. From the drawings given in the paper, the volume of the pouring basin works out at 700 ml., but the total volume of the castings appears to be 872 ml. It is therefore obvious that the pouring basin was topped up during the cast in the case of the longer down-runners, but may have been allowed to drain in the case of the short down-runners. This variation in head would account for the variations in the casting time and therefore for the variations of the loss-coefficient found.

For bottom gating, the authors supply the following data:

Down-runner area	4.5	—	—	—	—	—	sq. cm.
Runner area ..	1.05	2.00	3.75	4.50	6.75	8.25	sq. cm.
Casting time ..	1.99	1.54	1.26	1.29	1.70	1.95	secs.

The casting time, therefore, was a minimum if the ingate area was slightly less than the down-runner area. The authors work out a mean velocity and from that an equivalent head, which, however, has little significance as the arithmetic mean was taken. They noted that if air was admitted to the down-runner by a special vent, the casting times increased 77.5 per cent. respectively; 64.3 per cent. if the vent entered the down-runner; and 7 per cent. respectively 17 cm. below the down-runner entry. For the case of step-gating, they noted that the amount of flow through the upper ingate depended on the relation of the size of the lower ingate to the down-runner area.

Rate of Flow

Further experimental data on the effect of various factors on the rate of flow are given by the following investigators: Bochvar[3] using water in Perspex moulds, found that, for heads up to 47 cm. high, the down-runner diameter, once it exceeded 1.5 cm., had no effect on the rate of flow. This conclusion may have been due to a choke occurring at the bottom of the down-runner. Robertson and Hardy,[41] casting bronze into sand moulds, found that variations of pouring temperature, sand moisture and length of runner had no effect on the speed of flow, which, however, appeared inversely proportional to the runner area. Mezoff and Elliott[42] casting magnesium into sand moulds, found that the down-runner perimeter/area ratio was inversely proportional to the rate of flow. Narrow, rectangular or finger-type down-runners showed a higher loss than square or round ones. The pouring temperature had no effect on the rate of flow, and the down-runner length no effect in the case of round or square down-runners. The length seemed to have a slight effect in the case of very narrow down-runners and was proportional to the rate of flow in the case of tapered down-runners. The head in the pouring basin was in all cases found to be proportional to the rate of flow. In a later paper[58] the same authors investigated the degree of aspiration through the down-runner walls and found it to be proportional to the head in the basin and to the mould permeability. Aspiration was reduced in taper down-runners and disappeared in narrow slot-type down-runners.

Wall Friction

The measurement of the coefficient of wall friction of molten metals flowing in ducts was first attempted by Kirstenpfad[43] with cast iron. His apparatus consisted of a down-runner leading into a long horizontal runner carrying two externally-heated risers acting as pressure gauges. The rate of flow was controlled by varying the exit area from the runner. From the difference of head in the two risers Kirstenpfad calculated the kinematic viscosity by means of Hagen-Poiseuille equation, the velocity of flow being found by measuring the rate of flow. The use of the above formula seems justified in view of the fact that the Reynolds number was kept in the region of 1,000 for all tests, so that it is likely that laminar conditions existed. The resistance coefficient is then $64/N_R$ and was found to be 0.053 to 0.070. The author states that experiments were also made with bent runners and runners of non-circular shape, but no data are given beyond a note that triangular cross-section runners and sharp corners showed the greatest resistance.

Ruff[14, 15] calculated the speed of flow by measuring the distance covered by a jet flowing freely out of a runner of a given height. By using two runners of different length from this same down-runner, he calculated the retarding force and from that the resistance coefficient. For steel and malleable iron in sand moulds he found it to be 0.015 resp. 0.02 for a Reynolds number of about 10,000. From these data and graphs determined by Nikuradse and others he deduced that the lower critical limit for steel is about 3,500 and for malleable iron about 7,000. Rabinowitch[46, 47] considers that, as Ruff's values all lie in the indeterminate region between turbulent and laminar flow, the extrapolation was not justified, and further measured the speed of flow across the section of a stream of cast iron flowing in an open channel, concluding that cast iron behaves exactly like water in respect of pressure and velocity distribution. This conclusion is attacked by Kunin[48] as erroneous. Kunin constructed an apparatus measuring the speed of flow of molten metals in closed conduits by means of a series of electrical contacts, but gives no experimental data at all.

Theoretical Series

A theoretical investigation of the gating systems, treated as purely hydraulic systems, was first attempted by Kieswetter[49, 50] He obtained as general equation for the flow through any gating system

$$H = \frac{v^2}{2g}\left[1 + \sum kj + \sum \frac{a^2}{a_i^2} \times k_i\right]$$

where H, is the actual head; v, the velocity of flow into mould; k_j the loss coefficient in ducts of ingate area "a"; and k_i the loss-coefficients in ducts of area "a_i." The author mentions the large difference in the surface-tension of water and molten metals, and suggests that the loss-coefficients for metals are therefore different from those for water. No data on the actual loss-coefficients are given. Systematic work on the hydraulics of molten aluminium was carried out recently by Richins and Watmore,[51] who measured velocity and pressure conditions in top-poured sand castings of simple shape. The values they obtained for loss-coefficients agree well with those used for water in general hydraulic practice.

Principles of Gating

A thorough report dealing with the rate of flow if metals into castings was published by Hess,[52] who also gives a bibliography of some Russian and Polish investigations not available here. In addition to a graphic representation of the work done by Dietert, values are given for the overall loss-coefficient for cast iron and steel. It is interesting to note that different values are given for "green" and dry moulds, but that no differentiation is made between top and bottom gating, though special factors are given for moulds incorporating particular features. For the case of flow from a ladle through a bottom orifice, the effective head is given as

$$H_e = \left(\frac{\sqrt{H_1} + \sqrt{H_2}}{2}\right)^2$$

where H_1 and H_2 are the initial and final levels of metal in the ladle, as measured from the orifice upwards. Finally, Hess quotes the results and nomogrammes worked out by a Russian investigator in 1934, who assumed the casting time to be proportional to the cube root of the casting weight and the casting thickness. The proportionality factors are given—varying from 1.3 to 2.0, and once the casting time and the effective head are known, the dimensions of the ingate can be calculated from the basic hydraulic equations of flow. The final equation given is:

$$A_i = W^{\frac{2}{3}}\, t^{-\frac{1}{3}}\, H^{-\frac{1}{2}}\, z$$

where A_i is the total ingate area (in sq. cm.); W is the casting weight in kg.; H is the total head in cm.; and z is a constant depending on the gating system, the type of casting, and the mould. This constant

$$z = 1/\rho\, K\, k_1 \,.\, 0.0443,$$

where ρ is the density in cm./cc.; K is the overall loss-coefficient; and k_1 is the proportionality factor referred to above.

CONCLUSIONS

It is clear from the investigations carried out that, both in theory and practice, it is possible to relate the dimensions of the gating system, the weight of the casting and the casting time, provided allowance is made for the type of gating system employed (*i.e.*, top-gating, bottom-gating, etc.). Equations have been given for all cases except step-gating. In all cases the ingate area is inversely proportional to the square root of the effective head and a function of the casting weight. As to the exact nature of this function, investigators differ. Ingate area is given by some as proportional to the casting weight, by others as proportional to the root of the casting weight; Kieswetter quotes it as proportional to the cube root of the weight and Hess as proportional to the two-thirds power of the casting weight. This discrepancy is no doubt caused by the desire to account for some of the factors involved in casting, such as the solidification time, or the wall thickness. Theoretically, the ingate area should be proportional to the casting weight itself.

The proportionality constant has been determined by many authors and the results are given in Table I.

TABLE I.—*Overall Loss-coefficients ("K") in Gating Systems.*

Investigator.	Ref.	Liquid.	"K."
Osann	30	Cast iron ..	0.15 to 0.19
Lehmann	28	,, ..	0.866
Miaskowski..	33	,, ..	0.6 to 0.67
Petin..	24, 25	,, ..	0.15 to 0.78
Lehmann	28	Steel ..	0.837
Lehmann	28	Aluminium	0.922
Benkoe	29	,,	0.31
Swift, Jackson and Eastwood	4	Water ..	0.75 to 0.9
Grube and Eastwood ..	5	,, ..	0.7 to 0.93

TABLE II.—*Loss-coefficients for Specific Losses ("k.")*

Investigator.	Ref.	Liquid.	"k."	Remarks.
Bends.				
Doliwa ..	36	Cast iron ..	0.33	
Igarashi and Ohira	39, 40	Aluminium	2.0 to 0.15	Bend of 135 deg.
				Bend of 30 deg.
Richins and Watmore	51	Aluminium	1.8	Sharp bend
			0.4 to 0.5	Round bend
			1.2	Bend with sump
Hydraulic practice		Water ..	1.2	Sharp 90 deg. bend
			0.2 to 0.5	Round 90 deg. bend
Wall friction.				
Kirstenpfad ..	43	Cast iron ..	0.053 to 0.07	Circular duct in sand
Ruff	44, 45	Malleable iron	0.02	Circular duct in sand
		Steel ..	0.015	Circular duct in sand
Richins and Watmore	51	Aluminium	0.02	Circular duct in sand
			0.06	Square duct
			0.07	Slot
Hydraulic practice		Water ..	0.02 to 0.06	Average values for circular duct

Table II gives the loss-coefficients obtained for the flow of molten metals for specific resistances quoted. Corrections for the effective head in the case of bottom-gating have been suggested by Petin, Dietert and Kieswetter. The widely differing values in Table I seem to indicate that due allowance for the effect of back-pressure in bottom-gating must be made. As far as can be ascertained, values of K in Table I above about 0.6 refer to top-gated castings and the values below 0.3 to those bottom-gated. The values given in Table II are for use in equations of the type given by Kieswetter and some comparative data for water taken from general hydraulic literature are also included. It will be seen that loss-coefficients for molten metals are of the same order as those for water, indicating the similarity of flow between those two liquids. The loss-coefficient is a measure of the degree of turbulence in the case of bends, and is higher for a sharp bend, for instance, than a rounded one. Loss-coefficients for the more complex shapes encountered in castings, such as branches, have not been determined for metals.

No work appears to have been done on the determination of the relative areas of cross-section of the various components of a gating system. Many empirical data, however, are quoted in the literature and these are summarized in Table III.

As to the effect of various casting factors on the rate of flow, opinion seems unanimous that flow

TABLE III.—*Ratios of Cross-sectional Areas of Down-runner/Runner/Total Ingate Area.*

Author.	Ref.	Metal.	Ratio.	Remarks.
Osann	30	Cast iron ..	1:1.44:0.81	
Giessereipraxis	53	,, ..	1: 0.81	
Frede	32	,, ..	1:0.75:0.5	
Lehmann ..	28	,, ..	1: 0.75: 0.5	
Lips and Nipper	35	,, ..	1:0.75:0.5 1:0.9 :0.5 1:0.95:0.9	Radiators
Doliwa ..	36	,, ..	1: 0.75: 0.5	
Miaskowski ..	33	,, ..	1:0.75:0.5	
Hess (quoting Russian authors)	52	,, ..	1:0.81:0.625	Castings over 10 tons
	52	,, ..	1:0.86:0.715	Castingsbelow 10 tons
	52	,, ..	1:0.96:0.9	Thin - wall castings
Paschke ..	58	,, ..	1: 1.2 : 0.9	
Hess	52	Malleable iron	1:0.67:1.67	Thin - wall castings
	52	,, ..	1:0.5 :2.45	Thick - wall castings
Hess	52	Steel ..	1:0.81:0.625	
	52	,, ..	1 : 1:1	
Hall	56	,, ..	1 : 1	
Johnson, etc. ..	8, 9, 10	Aluminium	1.0 :2.0	
Miaskowski ..	33	,,	1:0.375:0.25	
Swift, Jackson and Eastwood	4	,,	1:2.0	
Howarth ..	26	,,	1:2.2 :2.0	
Grube and Eastwood	5	,,	1:2.0 :4.0	
Cristello ..	54	Magnesium	1:1.4 :1.4	

rate is very little affected by casting temperature (provided, of course, that the metal is fluid enough to fill the mould) and moisture in the sand. Down-runner and runner diameters affect the speed of flow only if they are below 10 to 15 mm., when they retard it. Some controversy exists as to the effect of down-runner length on the speed of flow. Most investigators in their equations use the entire down-runner length, with, in some cases, a correction for the head in the pouring bush and also back-pressure. Experiments, however, have shown that in the case of direct top-gating, in some cases the down-runner length had no effect on flow speed, in others it was effective up to a certain length only, but, in the case of water, down-runner length always influences the flow speed. This seems to indicate that there are certain surface-tension factors which become apparent in the case of direct top-gating.

Appendix "A"

Laminar flow: All particles in the liquid move parallel to each other, in the direction of flow.

Turbulent flow: Particles of the liquid move at random in directions other than the direction of flow.

Reynolds Number: A dimensionless parameter equal to the product of the speed of flow and the diameter of the duct divided by the kinematic viscosity.

Lower critical speed or lower critical Reynolds Number (N_r). That speed or equivalent Reynolds Number below which flow is always laminar.

Kinematic viscosity: The absolute viscosity of a liquid divided by its density.

Head: The height of liquid above any chosen reference level. In the case of castings the ingate or lowest part of the casting is usually chosen as reference level.

Effective head: The actual head less any energy losses expressed as their equivalent head.

Toricelli equation: The speed of flow through an orifice at the bottom of a vessel is proportional to the square root of the head times twice the acceleration due to gravity.

Bernoulli equation: The mathematical expression of the theorem that the sum of potential energy, kinetic energy, pressure energy and energy loss to friction in any given system are constant.

Overall loss-coefficient: The ratio of the actual quantity flowing through any given system to the theoretically possible maximum quantity.

Resistance loss-coefficient: A constant, which, if multiplied by the square of the speed divided by $2g$ gives the head equivalent of any energy loss.

For further details of the hydraulics employed here the reader is referred to any textbook of hydraulics.

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Scottish Ironfoundry Review

By our Special Correspondent

Any review of the light iron-casting industry in Scotland must take into account three factors—the supply of raw materials, the situation in the home market, and the overseas trade. Considering these three factors and their effect on the industry in the past year, it must be made clear that 1952 has been a year of exceptional difficulty and disappointment in the industry.

In the first instance, material difficulties had to be overcome by the ironfounders, and for a time employment was jeopardized as a result of a lack of a steady flow of pig-iron. This was particularly so in the early part of the year, and it became necessary to adopt stringent economy measures in the use of materials and to conduct scrap-gathering campaigns to collect small supplies for re-processing. By such emergency methods, founders were able to keep the moulding shops employed during a period when, at first, it was thought that lack of materials would inevitably lead to wide-scale unemployment.

Fortunately the situation slowly improved, and this difficulty was eased by an increased flow of pig-iron from the blast furnaces. Early on in the year, it became apparent that the impetus was dying out of the post-war "boom." The heavy demand for castings of all descriptions required for the rebuilding of a war-shattered economy began to fall off and founders were reluctantly forced to admit that no longer had they to satisfy a hungry market but to seek ways and means of maintaining sales in an era of lowered demand.

Market Restrictions

The situation facing the foundries had hardened by the middle of March. Restricted trading conditions at home were complicated by further restrictions in trading facilities with the export markets. The closing of the Australian market, in particular, adversely affected the foundries, for Australia from the end of the war until the Commonwealth Government imposed import restrictions had been a valuable market for cooking appliances, baths and other foundry products. Qualified satisfaction has been expressed by the announcement that Australia is to relax her import ban from January, to the extent of about £16,000,000 in a year, but it is not yet known how this relaxation will affect the export of foundry products from this country. Scottish founders, however, are hopeful that it will enable them once again to start exports to the Commonwealth.

Housing

Fortunately, the continued emphasis on the housing programme at home provided an outlet for a variety of castings—heating and cooking appliances, baths, and rainwater and soil goods—but set against this was a falling-off in the replacement trade, on which many of the foundries in the Falkirk area depend for a large part of their business. This was particularly so in the case of foundries specializing in the manufacture of baths.

Despite all these difficulties, the founders continued in their wise policy of stressing the need for research and for improving foundry techniques. Steps were taken to advance the programme of mechanization which in recent years has practically revolutionized foundry practice. Mechanization, too, made a great contribution towards the solution of many of the labour problems in the industry, as it enabled highly-skilled men to be diverted away from tasks which could be efficiently performed by mechanical means. In the realm of research, further developments were made in the direction of producing cooking and heating appliances designed to save fuel either by more scientific methods of combustion or by heat conservation. By reason of the prevalent fuel shortage, such appliances gained widespread popularity.

Training

During the year, too, increased attention was given to the training of apprentices. It was recognized that under modern conditions, apprentices could not be fully trained simply by letting them work along with journeymen in the production departments, and accordingly special schools were established. The aim of these has been to give the apprentices a general all-round knowledge of foundry practice. It is also the policy of the founders to use the apprentice-training scheme as a means of selecting workers for future executive positions in the industry.

In the future, the urgency of the housing problem at home, for instance, is expected to maintain the demand for rainwater and soil goods and for the other light iron-castings necessary for the building trades. Within recent years an aesthetic revolution has taken place in the light iron-castings industry. The day of gargantuan grates, made hideous by cast-iron over-ornamentation, is over and the convention of burnished edges and black-leaded surfaces has been abandoned. Founders in the immediate pre-war years realized that the obvious solution to the quest for improved appearance was the introduction of colour and the abolition of the drabness which had previously characterized cast-iron goods. Vitreous enamelling processes have well solved the colour problem. Iron-founders can now offer a wide range of colours and vitreous enamelling is popular with customers. No user who has had experience of keeping a vitreous-enamelled cooker or stove clean with an occasional wipe from a damp cloth will ever willingly go back to the drudgery of black-leading.

Fatality from Burning Clothing

An inquest of interest to foundrymen was held in Birmingham on January 2, when the City Coroner enquired into the death of a 51-year-old furnaceman employed by the Universal Steel Tube Company, Limited, who died from burns sustained when his clothing caught fire. Mr. Alan G. Farrow, managing director of the firm said that the man's job was loading tubes, and questioned about safety measures, stated that the furnacemen wore sack-cloth aprons, a practice common throughout the trade, but they usually removed them when attending to ashes. In reply to the Coroner (Mr. G. Billington), Mr. Farrow admitted that there would have been a certain amount of grease on the tubes, and questions about safety measures, stated that it was thought that a heavier type of apron would not be acceptable to the furnacemen, and it had been found that posting warning notices had little effect. The firm was now considering the advisability of treating the aprons with a fire-proofing solution. It was stressed that this was the first case of a furnaceman's clothing catching fire since the factory opened in 1930. The jury returned a verdict of "accidental death following burns sustained while at work," and the Coroner said there was no evidence of negligence on the part of the firm. The wearing of sacking aprons was common practice throughout the trade.

Core-assembly as a Production Aid to the Jobbing Founder*

By E. H. Beech and J. Hoyes

(*Continued from page* 39)

Block-pattern Condenser Shell

Fig. 18*a* shows a standard block pattern that was used in producing a condenser shell casting. This casting is subject to rigid inspection and dimensional checking before shipping. The pattern is 8 ft. square and 2 ft. deep with an additional exhaust branch 8 in. deep; the weight is approximately 10,000 lb. As a moulding problem, obviously this pattern would not provide the average foundryman with any difficulty, but for the sake of comparison, it is proposed briefly to describe the method used to produce a casting from this pattern. The salient point is, of course, the number of skilled hours required.

To consider placing a pattern on a dummy top and turning over, presented a problem owing to its weight when rammed up, thus one was compelled to bed the job in. The pattern (Fig. 18*b*) was placed on a level facing-sand bed and because the pattern face carried so many rib bosses at different levels, considerable time was spent obtaining a sound mould face. It was indeed an operation requiring the help of highly-skilled operatives. Then, the 11 by 10 ft. frames were placed round the pattern and rammed up to the top joint, a small drawback being placed at each corner to facilitate the withdrawal of projections. The top was then gaggered or gridded, whichever was preferred (for both are long-drawn-out processes) then after the pattern was drawn, many valuable skilled man/hours were spent in finishing the mould ready for the stove. Though space has been taken up in explaining the moulding technique and the mass of detail associated, which may be obvious to foundrymen, it is now deemed desirable to emphasize that by the method of core assembly, much of this detail work and the valuable time occupied by it is eliminated; hence, demands upon the time of skilled and unskilled labour are much less acute.

Equipment for Core-assembly

Fig. 19 illustrates the only pattern equipment used for the moulding by the core-assembly method. It shows the bottom face of a block pattern plus 9 in. of print seating. An important detail in core-assembly is to start with a good foundation and seating, for thereafter no trouble is experienced in building-up the mould—hence the large seating prints for the side cores. The pattern was placed on a dummy top, faced up, sprigged, rammed by sandslinging and turned over. The pattern was then drawn, the mould finished and stoved. At this stage, the mould was rammed, finished and stoved, in approximately 50 per cent. of the time taken to bed in a block pattern. Fig. 20 shows the mould ready to receive the cores. This mould represents a much simpler one for finishing.

In Fig. 21 there is shown the main body corebox, with the exhaust branch dowelled on the side members of the box. The internal flanges were made of metal and left in the cores until after drying, this enabled the cores to be produced in oil-sand. Fig. 22 shows the cores produced by the equipment shown in Fig. 21.

For the core-assembly method, the pattern and corebox equipment was modified. As a result, the founder is faced with an operation demanding reduced skill, enabling the job to come within the scope of sandslinging. This is a most important aspect for it is thought that sandslinging, correctly handled, can eliminate much of the laborious effort, if sufficient thought is given at the patternshop stage, and equipment is built to suit the machine.

Fig. 23 shows the top corebox and core, which was rather a large core to be made in oil-sand, and to facilitate handling, a special plate was made with which to turn out the core. The latter was then bolted to the plate from the main core grid, then the core and the grid were turned over on blocks, and the plate removed, thus leaving the core ready for picking up and placing in the mould. Fig. 24 shows the body core and in this connection attention is drawn to the " scotch " which is cast on the main grid. The object of this was to simplify the holding-down of the core, so eliminating the use of studs or chaplets. There had been a tendency for

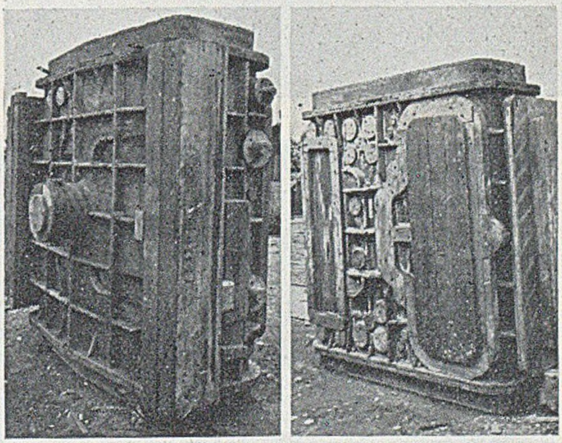
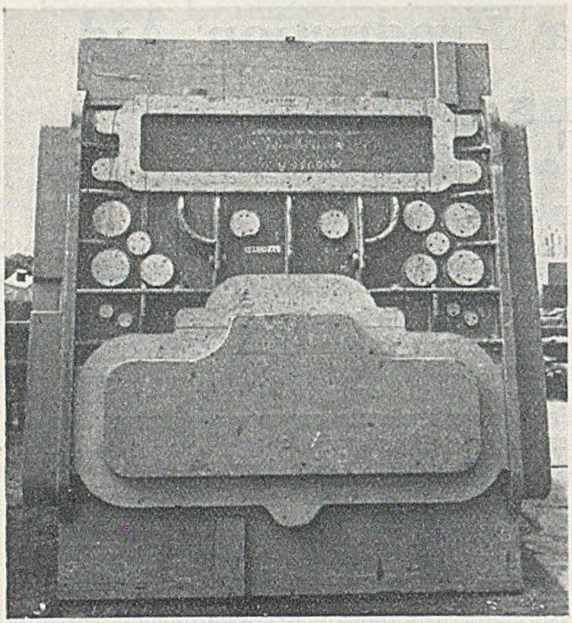
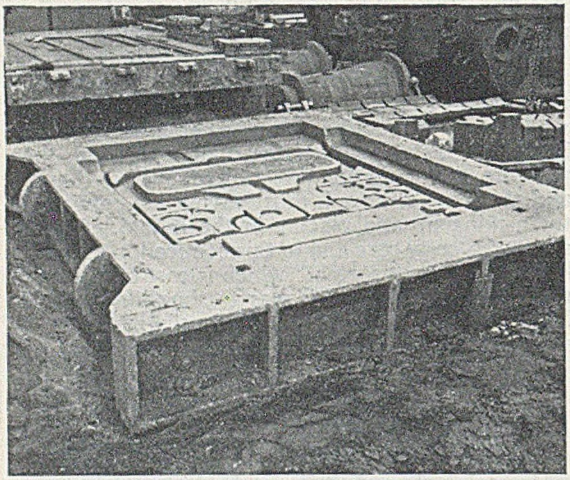


FIG. 18 (*a*) *and* (*b*).—*Two views of a Standard Block Pattern used to Produce a Condenser-shell Casting measuring 8 ft. square by 2 ft. deep and weighing nearly 4½ tons.*

* Presented to the Lancashire branch of the Institute of British Foundrymen.





the core to lift slightly and interfere with internal fittings. In Fig. 25, the side cores are shown assembled. At this stage, the joints were made up to eliminate possible marks on casting. The method of gating is also shown, and was comprised of two 1½-in. square downgates from which two 1¼-in. dia. ingates ran into the radii of the flange. At this stage, the ease and cleanliness with which the operator was able to work, will obviously commend itself. To finish the job the body core had to be assembled and the frames rammed up. It is also worth noting, before proceeding further, that it is possible by this process to see all parts of the mould for checking section thickness.

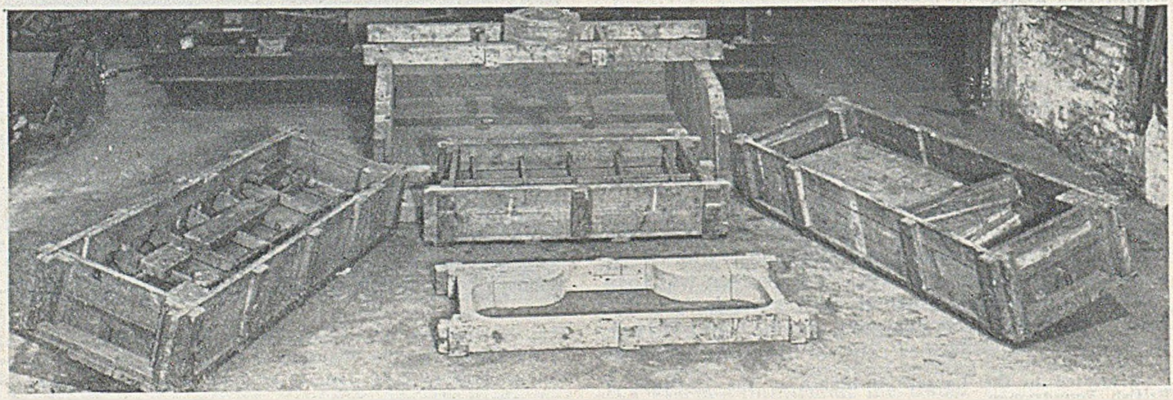
Top core being lowered into position is shown in Fig. 26. In the early stages of manufacture, four large risers were rammed in this core, one at each corner, and these were used as sight holes for checking the register after the core was in position but owing to amount of dressing and danger of damage to the flange, sight holes were used for first setting only; the core was marked and picked up; the sight holes were made up, and the core was reset to the marks for the final closing. Fig. 27 shows the assembled job ready for pouring, whilst Fig. 28 illustrates the resultant casting.

Twelve such castings were made during the year and each was dimensionally correct and sound. All of them received the engineers' approval, which eradicated any doubt regarding accuracy. The Authors would here point out, that they deliberately omitted from the printed description several important details with the object of stimulating discussion, but add the following observations:—There was a definite saving of 130 skilled man/hours per casting with the newer method, representing an increase of 36 per cent. in tons per man/hour; moreover, 20 skilled man/hours required for setting up the pattern were also eliminated. So that when

Fig. 19 (*top*).—*Pattern equipment for Moulding the Condenser Shell by Core-assembly Method.*

Fig. 20 (*left*).—*Condenser-shell Mould Ready for Insertion of the Cores.*

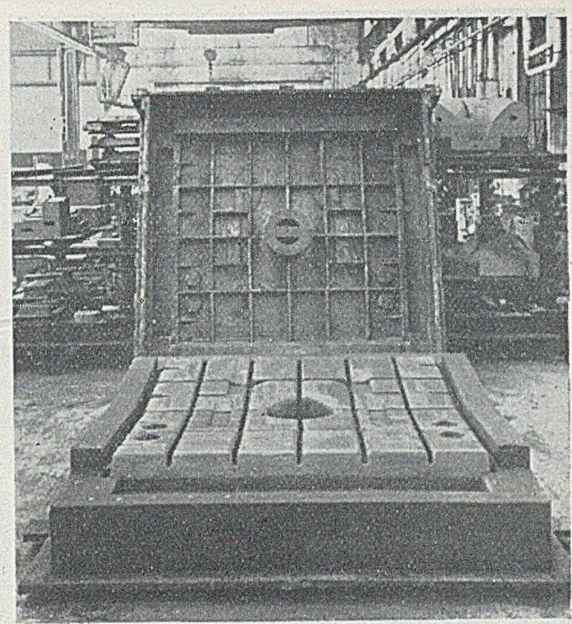
Fig. 21 (*below*).—*Main Body Corebox, with the Exhaust Branch dowelled to One of the Side Members.*



considering the cost of skilled labour plus overhead charges, and taking into account the unskilled labour saving, the end certainly justified the means. There was a higher rate of production and the castings were produced at a more economical price. The pattern equipment cost 10 to 15 per cent. less than the block pattern, and the design of the parts was simpler, and such jobs were efficiently rammed by sandslinging. The equipment also withstands wear and tear and damaged parts can easily be replaced. The manufacturing process proceeds in parallel and as a result of sub-assemblies which allowed the job to be distributed to several operatives, the job progressed at extra speed all through the shop; it was possible to ship the casting in eight days as against 21 days with block pattern. This procedure can be used with maximum efficiency where large quantities of castings are required.

Suppression of Dust

It is believed that moulding by core-assembly has a twofold advantage. Quite apart from the production hours saved, a considerable saving is also achieved in the unskilled man/hours absorbed. Previously, when using the block-pattern method, labourers, with occasional assistance from an overhead crane, would spend one whole shift knocking-out the boxes, stripping, and transferring the casting to the dressing shop. It was a dusty and laborious task, quite apart from the time factor, and posed a problem which the founder was most anxious to eliminate. By the core-assembly method, however, the frames are removed as soon as possible after casting. The rammed-up sand is still in a "green" condition, and is quickly collected and removed according to requirements, with the creation of a minimum of dust associated with reduced labour. When cool, the assembled cores are lifted away, and the casting stripped, the



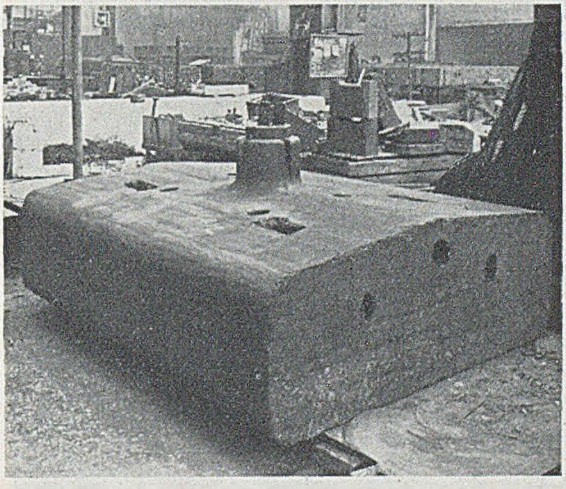
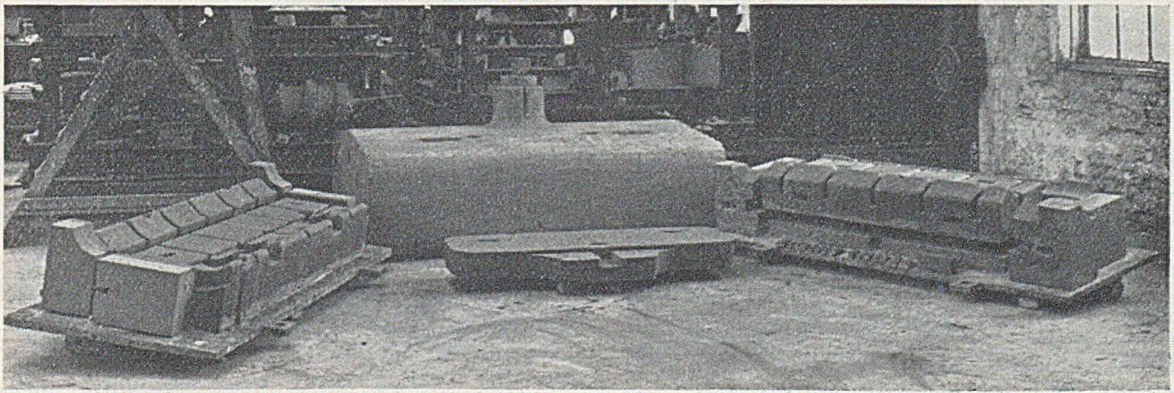


FIG. 22 (*below*).—*Cores for the Condenser Shell produced from the Equipment shown in Fig.* 21.

FIG. 23 (*top*).—*Corebox and Top Core made in Oil sand; a Special Plate was used for Turning it out.*

FIG. 24 (*right*).—*Finished Body Core for the Condenser Shell; note the "Scotch" used for holding it down.*



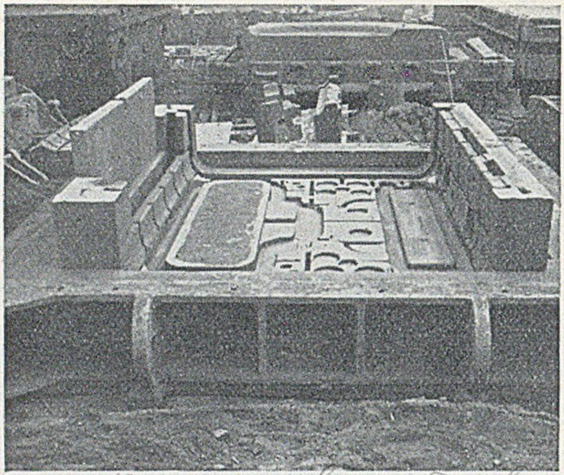


FIG. 25.—*Side Cores assembled in the Condenser-shell Mould.*

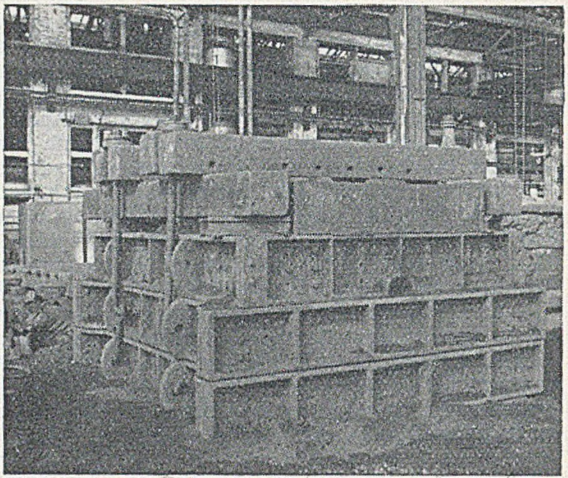


FIG. 27.—*Assembled Condenser-shell Mould ready for pouring.*

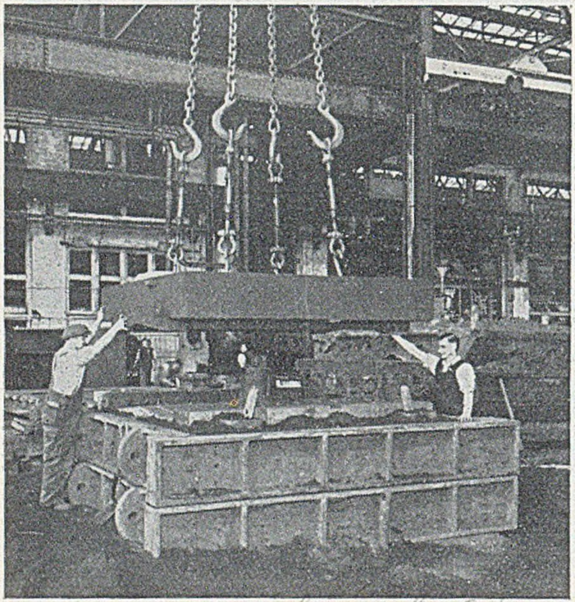


FIG. 26.—*Top Core being lowered into Position.*

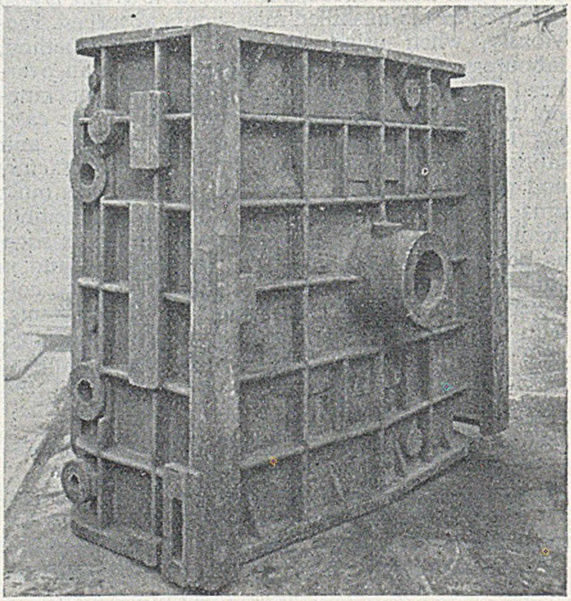


FIG. 28.—*Finished Condenser-shell Casting.*

whole operation taking only one third of the time required when the block-pattern method was used.

Exhaust Casing

Fig. 29 shows another example of an intricate casting (this time weighing 7,000 lb.) and necessitating a great deal of thought as to the best moulding method to be used. For block-pattern moulding, complicated drawbacks would be necessary at each side of the flange adjoining the skirt, to enable the trunk core to be printed, also there would be a drawback over the centre bearing to enable the bearing core to be seated. The job would then be rammed level with the skirts and the joint made. A middle part would have to be rammed up to level of the top circular flange, and this, of course, would require a grid, box-bars, gaggers, etc., and typifies a slow-moving operation. One can appreciate the high grade of skill which would be required to make the mould this way.

Fig. 30 shows the core-assembly layout for which no pattern was required. The picture shows the prints and mould ready for drying; the mould prints were placed on a black-sand bed, and from this the bottom mould-face was made; the prints are levelled off and finished. After drying the trunk core, the bearing cores were assembled, the moulder being in the position of having a full view of his work in progress, enabling him efficiently to secure the cores. Fig. 31, which shows the mould part assembled, clarifies the point, for it illustrates the position when all the cores were set, secured and studded in position. The picture was taken from the skirt side. Fig. 32 shows the position of the trunk core, which indicates how the moulder can see all sections and ensure a clean mould.

The next job was to assemble the top cores in position. The branch core would have to be split from the trunk core as the mould is undercut at this point, and the way to take care of this with the block-pattern method would be by the use of another drawback.

At this stage it would be appreciated that the amount of skilled moulding that had been eliminated was considerable; the mould was a simple build-up of four cores, as against three drawbacks in the skirt and a middle part gaggered and gridded, plus a further drawback to overcome the undercut of the mould around the branch core. Fig. 33 illustrates the built-up mould to complete the job, a loam plate 2 by 3 ft. was set covering the trunk side, and a smaller plate for covering the bearing side. Suitable frames were placed round the cores and rammed up. Finally, the circular flange was covered with a small plate, binders were put across the job, and tied down for casting. When cool, the box frames were lifted away, the mould cores and small plates taken off, and the casting moved to the dressing shop in under two hours (a very important point from the economy of unskilled labour aspect) causing the minimum of dust.

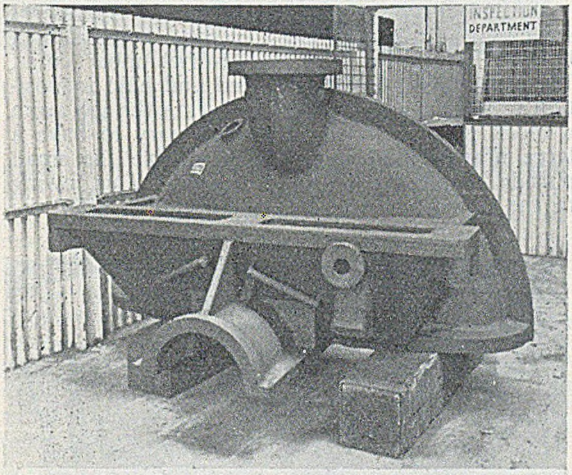


FIG. 29.—*Exhaust-casing Casting representing an Intricate Job if made from a Block Pattern.*

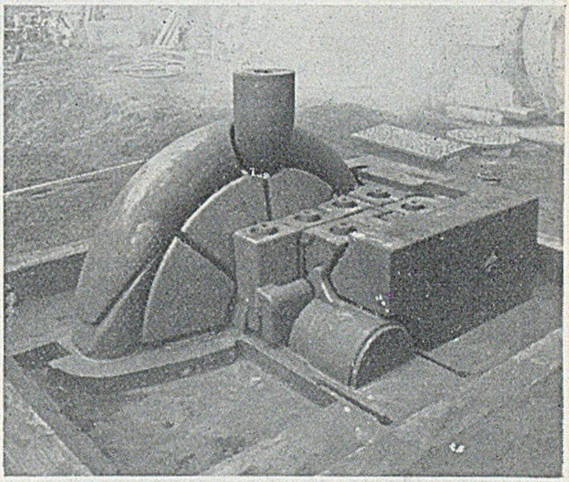


FIG. 31.—*Exhaust-casing Mould partly assembled, showing All Cores set, secured and studded in Position.*

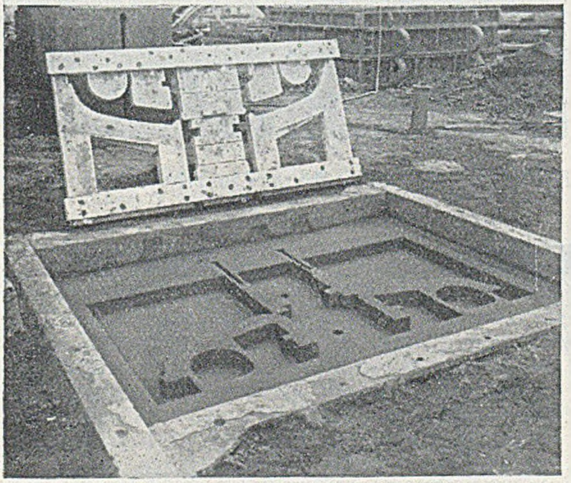


FIG. 30.—*Core-assembly Layout for the Exhaust Casing; No Pattern was required.*

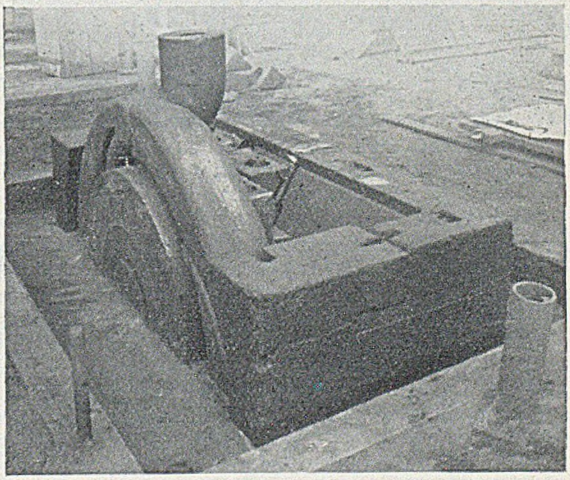


FIG. 32.—*Trunk Core assembled in the Exhaust-casing Mould.*

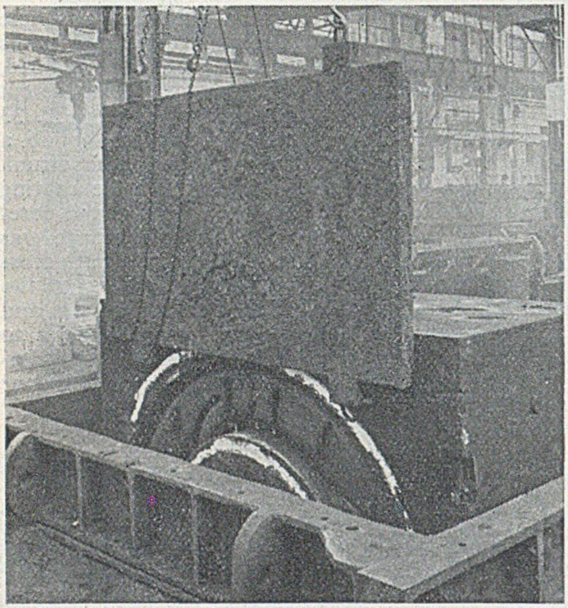


FIG. 33.—*Setting a Loam Plate to Cover the Trunk Side.*

Fig. 34 shows the trunk side of the casting. It was made in a mould carrying a very high permeability figure and one which was perfectly dry. This is desirable but not always obtained from naturally-bonded sand. Moreover, a much shorter drying cycle was used. The moulding tackle was simpler and subject to less wear and tear. There was an excellent finish on the casting, which when checked from the drawing was deemed to be dimensionally correct. The great advantage of the core-assembly method is that it can be adopted by any foundry, for even without sandslinging, cores of this nature could be hand-rammed much more quickly than the preparation of the job by three-parted moulding. The pattern cost is about 10 per cent. cheaper.

Compressor Half-casing

Fig. 35 shows another example which presents something of a problem, not so much in moulding, but in the seating of the interior-chamber cores. These must be accurately seated and held in position to meet the top half. Producing the job from a block pattern, it would be necessary to have a large drawback at each end to enable the small outside chamber cores to be seated. This, owing to the design, could only be assembled after the

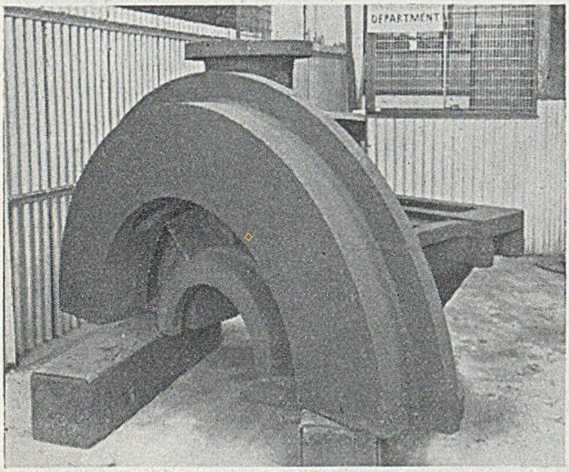


FIG. 34.—*Cores to form the Trunk Side of the Exhaust Casing.*

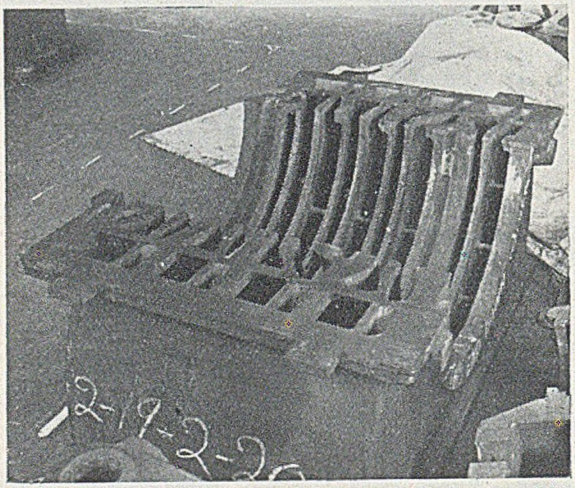


FIG. 35.—*Interior Cores for the Compressor Half-casing.*

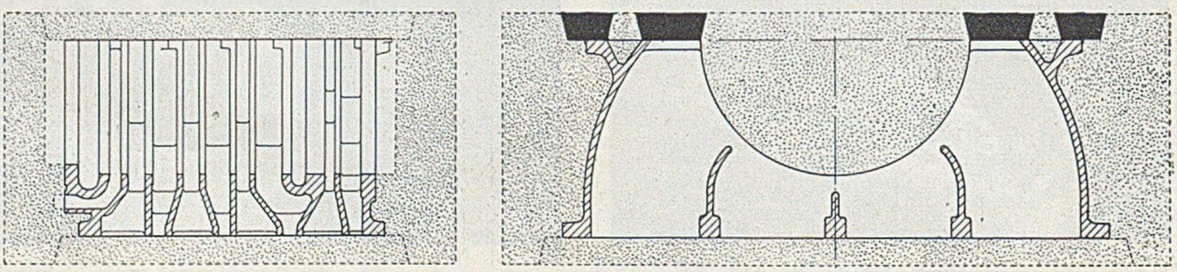


FIG. 36.—*Equipment for producing the Compressor Half-casing by the Core-assembly Method.*

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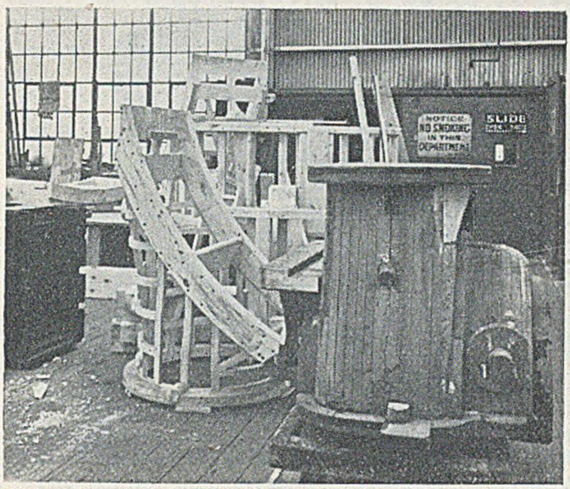


FIG. 37.—*Block Pattern for an Exhaust Casing (weighing about 27 cwt.)—Ordinarily a Three-part Job.*

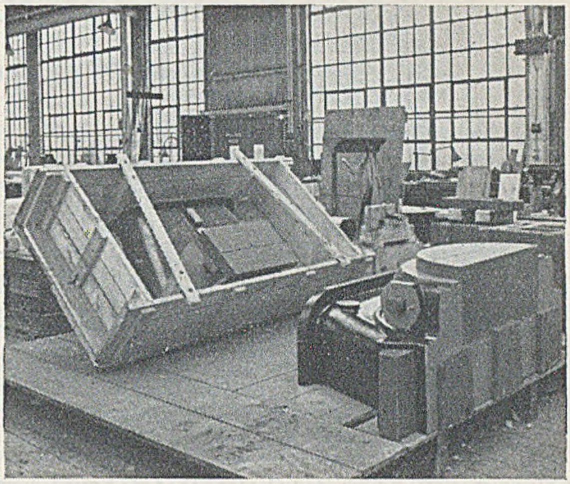


FIG. 38.—*Pattern Equipment for Making the Exhaust Casing as an Assembly of Cores.*

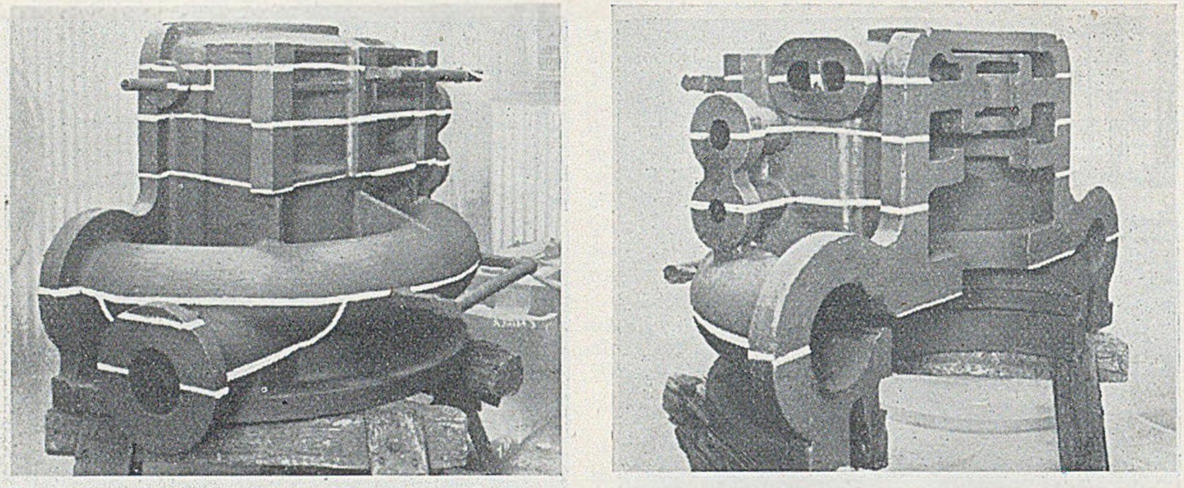
main cores had been assembled. Hence the need for drawbacks. The casting measures 7 by 4 ft. and is 4 ft. deep; it weighs 6,994 lb., and 70 skilled man/hours would be expended in moulding for its production.

Fig. 36 details the corebox equipment for production of the job by the core-assembly method. Instead of a block pattern all that was required were three coreboxes, making six cores—four for the sides and two for the top. All cores were of simple shape and made by sandslinging; the time taken by the coremaker was six hours; the job needed one and a half hours for dressing, making a total of 7½ hrs. The moulder was given a set of prints located in a frame. A top part was rammed by sandslinging and strickled-off level; the prints in the frame were placed on a bed and rammed with facing sand. After the prints had been withdrawn, the mould was finished and stoved in four hours.

After drying, this box was put on a level bed and the cores were assembled as follows:—The main bearing having been seated, each main chamber core was set using height and width gauges. Finally, the outside chamber core was assembled. At this stage is was possible to view all sections of the build-up. Next, the four outside mould cores were built around, suitable frames being placed in position and rammed up. The top cores were seated, bushed and cast up. The total time was 34½ hours. Broken down, the times, using the core-assembly method, were:—27 hours for moulding plus 7½ hours for the outside cores, a total of 34½ hours, representing a saving of 35½ hours of skilled labour, less the tie-up of the equipment, yielding an increase of 100 per cent. in tonnage per man/hour. The pattern expense saved on labour and material was of the order of 15 per cent.

A block pattern for an exhaust casing weighing 3,000 lb. (Fig. 37), again owing to its design, faced the founder with three-parted moulding. With ordinary moulding, it would be necessary to joint at the bottom flange, using grids, box-bars, etc., to carry the middle frames, with special reinforcement over the hubs to avoid sagging. Moreover, a drawback would be needed over the pedestal-end to facilitate finishing and coring. As the mould was lifted from the pattern, considerable overhead finishing would be unavoidable. After drying, the cores would be assembled and the middle frames closed over, reliance being placed on "clays" for determining the metal thickness; such a process would absorb 90 skilled man/hours

The pattern equipment for the new method using half block-patterns is shown in Fig. 38. The top-half was in a corebox, whilst the bottom half-pattern was faced up and rammed by sandslinging, finished and stoved; the top-half also was made in a corebox. After drying, the interior cores were assembled in the bottom half, and closed over with the cored top-half. Suitable frames were placed round the assembly and rammed-up to the top-part. The mould was then bushed and cast. It would appear that to put the half pattern in a corebox, brought in additional work and cost; however, it was done purposely to make full use of sandslinging. To adopt the normal two-piece pattern method, involving the use of gaggers, etc., together with bars in the box, would create a barrier to sand flow when moulding by sandslinging, resulting in irregular ramming. The total moulding time, including the making of the top-half core, was 55 hours, yielding an increase of 38 per cent. expressed in tonnage per man/hour. Figs. 39 and 40 show further examples of an intricate casing casting, which if produced from a block pattern would necessitate extensive printing out, and special moulding boxes to facilitate the seating of the interior cores. By the core-assembly method, no pattern was required, the mould being built by a slab



FIGS. 39 AND 40.—*Views of another Intricate Casting made without a Pattern by the Building-up of Slab Cores divided up as Indicated and Assembled in a Frame for Casting.*

core as illustrated—a much simpler operation. Suitable frames were placed round the mould and the interspace rammed-up. It was then bushed and cast in the usual manner.

Conclusion

Extensive research is still being carried out by the Research Division of the British Steel Founders' Association for improving dust conditions, and Mr. W. B. Lawrie, in his paper on this subject made this comment:—"The best method of controlling dust in foundries is to eliminate it at the source." This, indeed, is a long-term task for the jobbing founder, but the Authors believe that the core-assembly method is a progressive step in that direction, for one can strip a casting with the minimum of dust, and it represents a less laborious task.

In using the new method, founders are of course faced with the question of obnoxious fumes, but if the minimum of sand be used, and cores correctly baked so as to remove excess binder during the drying process, then in personal experience, some success has been achieved in controlling dust; combined with a more rapid production using lesser-skilled craftsmen and finishing with a more economic product. The craftsman represents a great part of a founder's capital, and with the present high overheads is a very expensive commodity. Therefore a careful study of how to use craftsmen, and experience of this core-assembly method, by which the cores which can be rammed by sandslinging, or be hand-rammed, may assist the industry to utilize skilled labour to its best advantage.

The Authors wish to thank Metropolitan Vickers Electrical Company, Limited, Trafford Park, Manchester, for permission to present this Paper, and Mr. A. Phillips, superintendent, and other members of the foundry and patternshop staff, for their assistance.

Vote of Thanks

At the conclusion of the reading of the Paper, MR. W. SPENCELY proposed the vote of thanks to the lecturers for such an excellent Paper on core-assembly work and complimented the speakers for the way in which certain large castings had been successfully made in their foundry by the method.

MR. W. AITKEN seconded the motion and remarked on the saving of skilled labour which had obviously accrued.

Dinner

MR. J. W. GAUNT

At the Queens Hotel, Birmingham, last week, the Flushing Cistern Makers' Association entertained Mr. J. W. Gaunt, who is retiring from the representation of his firm, W. & J. Lawley, Limited. Mr. G. H. Taylor presided and presented Mr. Gaunt with an illuminated address. The representative of his company, in the future Association affairs, will be Mr. J. W. Gaunt, junior. Mr. Gaunt, senior, continues as chairman of the company.

Precision Equipment (Pty.), Limited, Benoni, Transvaal, has been renamed David Brown Precision Equipment (Pty.), Limited, thus marking another stage in the controlled expansion and integration by the David Brown organization of its oversea interests. Before becoming associated with David Brown, the Benoni company had confined its activities mainly to the manufacture of jigs, gauges, moulds, dies, and special precision equipment. Since 1949 the company has increased substantially its output of these established lines, and has also produced several thousand gears and gear units of all types, including some of the largest ever made in South Africa.

Surface Finish and Facing Sands*

Discussion of Mr. Pell's Paper

After the Author had related his personal experiences with methods to eliminate scabbing from castings, members present at the meeting contributed from their knowledge of kindred matters tackled in a variety of ways. In this manner, moisture content, the efficacy of dressings, selection of raw sands, and the quality control of coal-dust and other coatings in both mechanized and jobbing foundries were dealt with in some detail.

Introducing MR. ROY PELL to the London branch of the Institute of British Foundrymen, the chairman, MR. L. G. BERESFORD, said that after a period as a student at the London Training College for Technical Teachers, Mr. Pell was to take up full-time teaching. Mr. Pell had been metallurgist at Hayward-Tyler, Limited, Luton, and had made a special study of foundry sands.

The Author then presented his Paper: "Surface Finish and Facing Sands."

MR. A. TALBOT asked if facing was used; some of the figures had made him wonder, especially the moisture figure of 3½ per cent. He presumed Mr. Pell meant the jobbing bay where jobs were done by hand. His own experience of the 3½ per cent. figure was that he had been able to get it down by a half per cent. to 4½ per cent. and he then found that castings were scabbing. At one time he had taken the mould to pieces and tested the facing sand after moulding and he had found that 6½ per cent., was being used. Was Mr. Pell sure that the sand was not watered down by the moulder ?

Replying to several points raised by Mr. Talbot, MR. PELL said no facing sand was used. One prepared sand was used for the face of the mould and backing sand, carrying 3½ per cent. moisture. The base sand Mr. Talbot was using might contain a high percentage of fines, in which case there would be required a higher percentage of bond to give the desired green-strength and, secondly, a higher moisture content would be needed. So that it did not follow because the Author's firm were using 3½ per cent. moisture in their sand that everyone else should do the same.

It was true it was necessary to moisten the mould in some cases, particularly where a very bad pattern was being used and there was patching to do, but that was the only case. It was very difficult to water sand, particularly synthetic sand, and to try to mix it with a shovel was hopeless. It was necessary to pass it through a mill.

Other Experiences

MR. A. EMMERSON said in their foundry they had been using synthetic sand for ten years. They had found at one period that their castings were bad and they had had to switch to wood-dust which had made a great improvement. Subsequently they had gone back to a modicum of coal-dust and wood-flour. The synthetic sand referred to was not novel. Repetition foundries could no doubt use synthetic sand at 3½ per cent. moisture, and get a perfect "draw," but he very much doubted if jobbing work could be kept going with a sand at 3½ per cent., because by the time the pattern was withdrawn there would be nothing left but a lot of dust.

The speaker was making a class of work ranging from a few pounds to about 4 cwt. and it had been found that intricate Diesel cylinder-heads could be cast up to that weight in green sand moulds. However, there was a great risk when assembling such intricate cores that the mould would be damaged and a high percentage of scrap caused. It had been decided that with castings of about 150 lb. and over, the moulds should be skin dried before casting. Starting with ordinary sand sprayed with plumbago wash, it was found unfortunately that when dried with a torch the mould became friable. On leaving out the bentonite and substituting a cereal binder the mould improved materially. If the mould was dried carefully, it was every bit as good as an ordinary dry-sand job on the face. In fact, sometimes dry-sand moulds were shown to be inferior to green-sand, but it took a long time to come to that stage. However, there was still the problem of intricate cores burning-in, and if Mr. Pell could tell him how to stop it he would be grateful.

Mould Dressing

About a year ago on a visit to a friend in a foundry in the Ardennes, he had been amazed to see being made the same jobs as he himself made, but the cores were devoid of any blacking whatever. A big crankcase was being made and, as foundrymen all knew, when the cores did not match up in the prints they were filed to shape. When he saw that was happening, he really expected trouble, but visiting the fettling shop he had been amazed to see that the castings were beautifully finished. Air-cooled cylinders also were a source of trouble, but the French founder could keep the bottom of the fins clean. In his own shop he had made many thousands of air-cooled cylinders, but they had only "got-by" and he was never proud of them. In the French foundry, however, they could make them without any blacking at all. It made him think it was something to do with the sand in use in the different countries.

He had tried sand from Erith, but because they had to use such a lot per day, it did not pass readily through the dryer and caused trouble. He had

* Paper printed in the JOURNAL, January 1, 1953.

switched over to a sand from Redhill, which was a beautiful sand, but did not give very good results alone, but if he used a percentage of fine sand, he got good results. He believed there was something to be said for using a percentage of fine sand; it seemed to lodge in the voids and prevent the metal from penetrating.

On making air-cooled cylinders by the new "C" process, using a high percentage of very fine sand a remarkable finish was obtained on the castings, but when using the normal sand the finish was almost as bad as when they were made by the ordinary method.

Also of consequence was the temperature at which the jobs were cast. His own firm poured at about 1,350 deg. C. and they could black and re-black the cores and yet not stop the metal penetrating. He was interested to hear 25 per cent. red sand had been used. This he had himself tried, and with 50 per cent. or even 75 per cent. and he could never stop the defect. However, he remembered as a boy, when oil-sand came in, one could make bed-plates satisfactorily, weighing up to 5 tons with sand from South Shields, which was not blacked.

Of course, if the much higher percentages of oil and binders that had been mentioned were used, his firm could get much better results from one respect, but they had to work at about 2½ per cent. binder on intricate jacket cores otherwise they ran into trouble with blowholes. With burning-in, it seemed as if the iron being used was more troublesome than a 1.0 per cent. phosphorus iron, which was cast at a very much lower temperature. Founders had a long way to go before such troubles were cured. A good blacking helped, but it did not cure.

Presenting Metal Penetration

MR. PELL entirely agreed that a most effective way to cure metal penetration in cores was to add fine sand. As he had briefly mentioned, his firm did use, on certain cores, zircon flour, which reduced the permeability down to about 20, to get a really good finish on the casting. That, he thought, was the best way to tackle the problem. He reported that his firm had failed hopelessly to produce a core sand with the high permeability sought and that they had had to resort to a low permeability. The function of zircon in a core sand was to lower the permeability, which was an important factor. But there was also the point that silica did go through a phase change as had been mentioned and rapidly expanded at quite low temperatures, causing the core to crack slightly and allow metal to penetrate. With zircon that phase change did not take place. To a certain extent, a percentage of zircon flour in the core sand helped; it behaved a little like wood-dust in that it reduced the total expansion of the body of sand. He suggested if there was no wood-dust, founders should try some zircon particularly in tricky cores. That would probably be used a good deal in the future to lower permeability and overcome the effects of expansion.

Casting Temperature

A MEMBER said for comparison purposes he would be very glad to know what sort of iron Mr. Pell was using because the type of iron he himself used was probably cast at least 100 deg. higher.

MR. PELL said though the sand was hand rammed, they did check mould hardness over the surface of the test block immedately after moulding. That was the only way in which the density of ramming could be checked.

The percentage of the metal used was carbon 3.3, silicon 1.8, and phosphorus below 0.2. As for casting at 100 deg. C. higher, that was possible, but for a block 12 in. square and 2 in. thick, 1,300 deg. C. was quite good. Higher temperatures were used on certain work, for instance, it was necessary for very thin impellers to go to 1,400 deg. and above.

MR. J. P. P. JONES, on the question of moisture content, asked whether it should be raised in proportion to the amount of wood-flour—possibly by a ½ per cent. for every 1 per cent. wood-flour added. Additionally, observations on the resin content of wood-flour in soft wood as opposed to the relative absence of resin in hard wood, would be useful. He thought Mr. Emmerson had touched on that point in referring to the shell-moulding process. He had mentioned metal penetration when a shell mould was removed from the pattern-plate carelessly and the surface damaged. Mr. Jones thought the surface there was given by the resin and when that was broken there was an opening which allowed the metal to penetrate. Did not, perhaps, a similar situation obtain in ordinary sand moulding?

On another remark of Mr. Emmerson's about cores, particularly those which were not blacked, was any knowledge available at that meeting on the use of sodium silicate and silica sand and wood-flour which he believed was used for core-binding purposes abroad? Could Mr. Pell give his view on the wide use of sea sand, which was extraordinarily popular, particularly that from Lancashire? It had one advantage, it had a round grain but in this part of the world it was a most expensive silica sand and its content of sea shells and the like was high. Yet the demand for it was persistent and considerable despite the availability near London of sands equally good and perhaps better.

MR. PELL said he regarded the figure of a half per cent. increase in moisture content for every one per cent. of wood-flour present as being about right. It agreed with his experience.

When Mr. Emmerson had spoken of using Erith silica sand he was surprised to learn that there had been trouble with it in the dryer. His firm were using a similar type of dryer and thought themselves very lucky to have a silica sand that fell through the dryer so easily. Thus, there was a possibility of some misunderstanding; was it possible that Mr. Emmerson had been using what was not regarded as a pure silica sand? He could only think that there must have been clay present to cause the lumps complained of. For all practical purposes Erith silica sand did not contain clay and it would be just impossible for that material to produce lumps in the Fordath dryer;

therefore it was possible that Mr. Emmerson had been referring to a different sand.

The resin content of wood-dust was, he believed, an important factor, but to what extent he could not say. For instance, he had no knowledge as to whether an increase in resin content was desirable because he had not had the opportunity of testing wood-flour containing an increased resin content.

Cores Without Blacking

Mr. W. Wilson said he could confirm what Mr. Talbot had already said about using cores without blacking. His firm had managed to make cores with an addition of Mansfield sand to give strength and finish. They had cast blocks weighing a ton or more in a synthetic core-sand without binder without any blacking at all and with no other than the natural finish of the sand. In other words they did not have to paint their cores at all. Of the three sands mentioned, they used none; they had tried them all and discarded them, due to metal penetration.

Mr. Pell thought he could not have answered the first question clearly. He thoroughly agreed it was possible to make castings with cores having no blacking. His original point was that to cast the particular steam cylinders mentioned with that particular port core assembly was impossible with a sand having a permeability of 100. That had been the point and he did agree that it was possible with another type of sand.

Dr. Einerl said his was one of those foundries that could not get 100 per cent. good castings! They had now practically abandoned oil-bonded core-sands for iron castings and had replaced them by additions of P.F. resins and starch to a local pit sand having the following characteristics:—Clay, ½ per cent.; moisture, 3 per cent.; 71 per cent. retained on A.F.S. sieve 60; and 25 per cent. retained on A.F.S. sieve 100.

This sand was milled after adding ¾ per cent. P.F. resin and 2 per cent. starch. To lower the permeability, sea sand was added, the grain size of which was much smaller. Could Mr. Pell give any idea of the clay content and grain size distribution. of the core sands used in his experiments?

Mr. Pell said he thought clay content was only small, about 1 per cent.; the majority of the particles were around 60 mesh or from 40 to 80.

Mr. Fraser asked if Mr. Pell had tried any experiments with Fullers' Earth. Was it possible to use it as a substitute for bentonite?

Mr. Pell said he had had no experience with Fullers' Earth. They used North African bentonite throughout.

Results Applied to Jobbing Work

Mr. A. R. Wizard wondered if the foundry about which they had been hearing was completely mechanized, and if it was, how much value from the small jobbing foundry point of view, could be attached to what members had heard.

Mr. Pell said he hoped he had not given the impression that his foundry was completely mechanized, because it was not. They had really set out to put the sand in order before mechanization was considered. The idea was to give moulders a sound material and the sand testing introduced was very elementary. Each hour the results were chalked up so that the moulders could see what they were, a practice he recommended for it was surprising how interested moulders became. He could assure members that when the record board had been in use for some time, if someone was not out testing the sand during the hour, the moulders would be bringing it into the laboratory.

Mechanization before introducing that type of sand was just not necessary. Originally, the practice was to mill the sand, lay it on the moulders' working area, and cover it with a damp sack and in that way sand had been kept for several days. He was surprised that no one had raised the problem of air-drying. Of course, there was a tendency for air-drying to occur, but by covering the sand with a damp sack it could be minimized. Later, they had introduced steel bins in which to store the sand.

As far as using it on a wide variety of work was concerned, the only item found necessary was a good pattern. If the moulders were given that type of sand with poor patterns they were soon in trouble. Good pattern equipment with the sand worked quite well under normal jobbing conditions on a wide variety of work. About two to three per cent. of bentonite along with about one per cent. of new silica sand were added to the mix and attempts were made to keep the coal-dust addition down to 2½ per cent. by the test which had been mentioned.

A member said that years ago in his recollection coal-dust was a glistening substance. Now it looked like shale powder. Did Mr. Pell think founders had been foisted off with ground-up shale?

Mr. Pell said that was possible, and led to the reason why his firm had decided to test coal-dust on receipt and had insisted on good material. A low ash-content had been insisted on and that immediately ensured that the coal-dust was ground from a good-class material, though he was not suggesting that ash content and volatile content were the only tests for coal-dust. Other factors came into it, particularly the rate of gas evolution for a given particle of coal and the size to which it was crushed. That side of the problem in the laboratory was beginning to become quite complex.

Coatings and Clays

Another member said his experience with that type of synthetic sand had been entirely with low-silicon iron cast at about 1,650 deg. C. With reference to zircon in core sand, he wondered if Mr. Pell had had any experience of zircon coatings for cores in the form of zircon flour and the like. His experience had been that North African bentonite was entirely useless at high casting temperatures, and that it was essential to have American bentonite.

Mr Pell could not answer the comment about the use of Wyoming bentonite. He had not had experience of steel casting, but if steel founders said that Wyoming was necessary, he thought it

Surface Finish and Facing Sands—Discussion

must obviously be true. In any case, his own suppliers would not send him Wyoming bentonite, they said that the North African variety was good enough and that from Wyoming had to be kept for steelfounders.

His firm had tried zircon in a host of core dressings but had found that the quality of the sand itself was much more important. If they could only find a good enough core dressing then they could step up the permeability to 100 again.

Vote of Thanks

MR. TALBOT, proposing a vote of thanks to the lecturer, said although he did not agree with all that had been said, Mr. Pell had brought valuable experience to the subject under consideration and had approached the matter from an entirely new angle which many had never had the time or inclination to do. He hoped Mr. Pell would keep this interest in facing sand because it was obvious that progress was being made.

MR. DANIELL, who seconded, said he had had the pleasure of working with Mr. Pell and he was sure there was more good work to follow. All would agree that not always were good castings produced and the core often seemed to be the place where metal penetration occurred. He regarded cores as individual items that needed treating as such, sands and dressings needing special attention. Mr. Pell had done a good deal of work in that direction and had advanced quite a distance from when all blame was placed "on the horses in the stable." No doubt members would join in wishing him every success in his new spheres of activity.

Acknowledging the vote of thanks, MR. PELL said he was grateful to members for the interest they had taken in the Paper. He had realized that in talking about sand he had been "sticking his neck out" and the fact that some had disagreed was just as it should be. He hoped they would not think even he had escaped being told of the way their fathers had done the job. His father was a foundryman and so was his grandfather—all practical foundrymen—so that in that direction he had had more than the usual amount of information and criticism.

In conclusion he would like to thank Mr. Daniell who, as foundry manager, had so often to explain away some of the castings that he had been responsible for spoiling. He would also thank Dr. Ivanhoff for his great encouragement throughout the work and also his many other colleagues at Hayward-Tyler's who were always a great help, and Mr. Mochrie who was so helpful with criticisms in the preparation of the Paper.

Institute of Indian Foundrymen

Two meetings were held in Calcutta during December, 1952 of the Institute of Indian Foundrymen. At the first, held under the joint auspices of the Indian Institute of Metals in the Hall of the Government Industrial Museum, 21, Chittaranjan Avenue. Mr. Prakash Gupta, foundry superintendent of Indian Malleable Castings Company, Limited, presented Papers on "Oil-fired Rotary Furnace Operation and Economics" and "India Requires Malleable Iron Foundries." This meeting was arranged in view of the keen interest that had arisen in the operation and economics of rotary melting furnaces for melting high-temperature metals such as steel. The second was held in the same hall, when Prof. G. A. Robinson addressed members on "Modern Developments in Management." Under the Technical Co-operation Scheme of the Colombo Plan for India, the services of Prof. Robinson have been loaned to the Government of India for six months. He was the former education secretary to the British Institute of Management and is to assist in working out details of management courses to be held at the Indian Institute of Technology, Kharagpur.

The Flick industrial empire, according to a message from Bonn, has now been released from Allied control. The High Commission has accepted a plan by which Herr Friedrich Flick will split up his coal and steel assets. Herr Flick will be required to sell his family holdings in two big Ruhr coal groups, and will turn over to his two sons the family holdings in the Maximilianshuette steelworks in Bavaria. The arrangement leaves out of the count the other Flick assets, which mainly comprise the Hochofenwerk foundry at Luebeck and the chemical plant at Bergkamen.

Controls on Electrical Goods Lifted

Controls on the manufacture and supply of electrical appliances were ended on December 30, when the Minister of Supply, Mr. Duncan Sandys, revoked the Machinery Plant and Appliances Orders of 1945 and 1948, and the Electrical Appliances Orders of 1942 and 1943. Under these orders, manufacture and supply of a wide range of machinery and electrical appliances were subject to the granting of a Board of Trade or Ministry of Supply licence.

The appliances now freed from control include machinery and plant for laundering, dry-cleaning, dyeing, and refrigerating, carding and card clothing, slot machines, cinematograph projectors using film of more than 16mm., and lawn mowers. Many electrical domestic appliances are also freed, including hair-waving and drying machines, cooking, pressing, drying, heating and cleaning apparatus such as water heaters, vacuum cleaners, car heaters and electric blankets, dry shavers, curling irons and drink mixers.

Wage Bill Increases

Wage increases amounting to £4,282,200 a week were granted to 11,085,500 workers during the first 11 months of last year. This compared with increases for 11,689,000 workers totalling £5,977,000 a week in the corresponding period of 1951. In November there was an estimated increase of £986,000 in the weekly full-time wages of about 2,905,000 workers. There was also a decrease of about £4,300 for 180,000 workers. These increases, which were larger than for any month since November, 1951, were due mainly to the fact that the rises for engineers, shipbuilders, and railwaymen all came into effect during the month.

Iron and Steel Bill

Report of this Week's Deliberations

The Minister of Supply, Mr. Duncan Sandys, discussed the provisions of the Iron and Steel Bill at a meeting lasting nearly three hours on Tuesday last with representatives of employers and trade associations of the industries principally affected. Discussion centred mainly on the position of the foundries in relation to the new Board which is to be set up under the Bill.

For and Against

Industrial representatives continued to express divergent opinions on this question. The British Iron and Steel Federation, the Joint Iron Council, the Council of Iron Producers and the Council of Ironfoundry Associations expressed approval of the inclusion of the foundries within the ambit of the new Board.

On the other hand, the British Steel Founders' Association and representatives of the engineering industries maintained their view that the foundries should be excluded from the Bill. It was also reported on Tuesday that, in the ballot arranged by prominent ironfounders, 1,190 ironfoundry owners agreed with the exclusion policy and only 86 expressed themselves in favour of foundries coming within the ambit of the Bill. The Council of Ironfoundry Associations condemn this ballot, first because they consider the questions, requiring as they did straight " Yes " or " No " answers, could not reflect shades of opinion or take cognisance of the C.F.A. contention that inclusion of ironfounders willy-nilly among those to be supervised was inevitable. Secondly, they claim that the number of abstainers is too high for it to be considered that the ballot was representative of the whole.

Second Reading Concessions

Notwithstanding the force of these arguments however, the Minister explained that, while the Government adhered to its decision to include the foundries in the Bill. He intended to introduce amendments to implement the assurances he had given to Parliament during the Second Reading to date. These were:—

(1) To ensure that the iron founders had a fair share of the materials available it was essential that they should be in the new set-up, and it was promised that the Board would include at least one member with foundry experience.

(2) It was not believed that there was any reason to suppose that the new Board would wish to extend the field of price control beyond what had existed for a decade. The Government would be prepared to consider in Committee methods to restrict the Board's powers to extend the area of price control and to restrict its price control powers to the very limited range at present price-controlled.

(3) The Board's powers over development only extended to very big schemes likely to alter the balance of the industry as a whole, such as those concerned with the heavy side of the industry. " It is extremely unlikely that any foundry development schemes can ever be big enough to be within the scope of the Board's powers," the Minister said.

(4) " It is the essence of the Bill that the iron founders should be free to manage their own affairs with the minimum control," said the Minister. " Provided, therefore, that it does not impair the comprehensive scope of the Board's supervision we shall be glad to consider on Committee stage any amendments designed to remove genuine doubts or to stop up unintended loopholes for bureaucracy."

Warning

The Minister, it seems, presented something of a warning to those associations which were campaigning against including the foundries in the Bill. He asked them to accept the general proposition to bring the foundries under the Board's supervision. If this were done, he would make amendments at the Committee stage of the Bill which would substantially reduce the authority of the Board over the iron founders.

If the proposition were not accepted, or if the pressure of opposition continued, he is understood to have warned the meeting, the Bill might have to go through as it stood. Mr. Sandys laid considerable emphasis, in appealing to the associations, on the need to meet trade union views in drafting the Bill.

A statement issued by the Ministry of Supply after the meeting reports that Mr. Sandys undertook to amend the Bill so as to ensure that the Board's powers were limited to those strictly needed to carry out its duties with regard to the foundry industry and to avoid any unnecessary encroachment into the affairs of the engineering industry. In return, the statement continued, the trade associations represented agreed to accept the inclusion of the foundries in the Bill, and to drop their opposition to the Government's proposals.

The following associations were among those represented at Tuesday's meeting with the Minister:—

The Federation of British Industries, British Chemical Plant Manufacturers' Association, British Engineers' Association, British Electrical and Allied Manufacturers' Association, British Iron and Steel Federation, British Steel Founders' Association, Engineering and Allied Employers' National Federation, Food Machinery Association, Joint Iron Council, Council of Ironfoundry Associations, Council of Iron Producers, Loom Makers' Association, Machine Tool Trade Association, Shipbuilding Conference, National Association of Marine Engine Builders, Society of British Aircraft Constructors, Society of Motor Manufacturers and Traders, Water Tube Boiler Makers' Association.

Ballot Report

" Britain's ironfounders are overwhelmingly opposed to any form of 'supervision' by the Iron and Steel Board which is to be set up under the new Steel Bill." This statement was issued to the Press as a result of the secret ballot undertaken by a London firm of chartered accountants and sponsored by 27 ironfounders " for the purpose of assessing the true opinion of the ironfoundry industry." The ballot showed that 1,190 companies object to the proposals and only 86 were in favour.

Ironfounders' replies to the ballot totalled 1,276. A further 197 firms were unable to complete the question form as they were not engaged in ironfounding, and ballot papers returned by the G.P.O. as having been undelivered totalled 36, thus reducing the potential number of foundries (assuming all those who did not respond were, in fact, ironfounders) to 2,155.

New Year Message

The following New Year message to members has been sent by Mr. N. P. Newman, chairman of the Council of Ironfoundry Associations:—

"At the outset of my message last year I expressed confidence that the final production figures for the preceding year, 1951, would show a record annual output. This prediction was indeed fulfilled to a degree which, in former times, would scarcely have been thought possible. It was hardly in the nature of things that the picture in 1951 could have been indefinitely repeated, and the year just passed has seen some slimming of order books. With the increase in the supply of pig-iron, which all have noted with relief, and the devoted work of so many of our people who give up time and energy unstintingly to further the interests of all ironfounders, we can look forward in 1953 to a year in which we should certainly hold our ground.

"I suppose that uppermost in the minds of every one of us must be the domestic difficulties which have arisen over the discussions on the Iron and Steel Bill. No legislation ever seems perfect to those whom it affects; therefore, from the issue of the White Paper to the publication of the Bill itself, and subsequently, the Council of Ironfoundry Associations has striven consistently, and with success, to obtain improvements in the measure. It should be more generally realized that the Bill gives legal shape to long-decided Cabinet policy, which is the basis we must accept. It was from that unavoidable starting-point that your executives and Council have carried through the strenuous work of the past few months, and have sought successfully to vindicate the claims of the industry before the Government. Much work still remains to be done in this connection, and we shall continue to do it with the same single eye to the well-being of the industry.

"Now, hard upon the heels of the Iron and Steel Bill, comes another proposed enactment touching on the health and safety of our workpeople. This, as I write these words, is receiving the closest scrutiny of your Council and its executives, your interests will be jealously watched, and all necessary action taken to protect them. In making that statement, I add that we forget neither the anxieties nor the interests and welfare of our employees in these matters.

"There is no finality in the development of an industry. Something new is always happening. At all times, there is ample scope for every ounce of active aid from the individual member. My most earnest hope for 1953 is that more and more of the vigorous, thinking men in our industry shall join in the work we do. If they come forward in greater numbers, they will most effectively help both their fellow-ironfounders and themselves. With a cordial invitation to them to do so, I couple my heartiest good wishes to all of you for the year now opening."

The Third International Congress on Electro-Heat is to be held in Paris from May 18 to 23. The programme includes sessions on electric melting, heat-treatment and associated subjects.

Mr. M. F. H. Geraghty, Northern Ireland secretary of "Aims of Industry," said in Belfast last Friday that within 48 hrs. of the receipt of ballot papers from his organization, to ascertain whether the Northern Ireland foundry industry was in favour of supervision under the proposals of the Iron and Steel Bill, an "almost 100 per cent." response had come from Ulster foundry executives likely to be affected by the passing of the Bill.

Obituary

Mr. Frederick W. F. Cahill, a member of the staff of Thos. W. Ward, Limited, Sheffield, died recently.

Mr. Thomas William Wales, managing director of Aldam (Misterton), Limited, engineers and ironfounders, of Misterton (Yorks), died recently at the age of 55.

Mr. Albert E. Chaffey, who was for many years chief mechanical engineer of Felt & Tarrant (Comptometer), Limited, calculating machine manufacturers, of London, W.C.2, has died.

The death is announced of Mr. Marcel Remy, the well-wnown and highly-respected Belgian malleable ironfounder. He was a member of the International Committee of Foundry Technical Associations and was a constant supporter of international co-operation.

Mr. Benjamin Spinks, who was for 22 years general manager of H. P. Parkes & Company, Limited, chain manufacturers, of Cradley Heath (Staffs), and subsequently a director and general manager of Richard Sykes & Son, Limited, chain and cable manufacturers, of Cradley Heath, died recently at the age of 65.

Prof. William Herbert Hobbs, one of the leading geologists in the U.S., who was engaged in the teaching of geology at the universities of Wisconsin and Michigan for more than 40 years, has died at the age of 88. He was Assistant Professor of Mineralogy and Metallurgy at the University of Wisconsin for nine years from 1890.

Mr. John Delooze, who was for many years secretary of Rolls-Royce, Limited, died on January 6 at the age of 80. He first became associated with the late Sir Henry Royce in 1893, when he was engaged as cashier by F. H. Royce & Company, electrical equipment manufacturers, of Manchester. When the motor manufacturing concern was founded in 1906, he was appointed the first secretary. He retired in 1943.

Mr. Harry Joyce, chairman of Tube Products Limited, Oldbury, and a pioneer in the cycle industry, died at his Aberdovey home on January 8 after a heart attack. He was in his 80th year. Mr. Joyce was also chairman of Mulliners Holdings Limited, the Birmingham firm of motor-body manufacturers. He entered the cycle industry in Birmingham over 55 years ago when he established his own business, H. J. Joyce, Limited; that company amalgamated with Tube Investments Limited in 1920.

Lieut.-Col. Sydney Smith died on January 4 at the age of 52. Col. Smith was director of Phelon & Moore, Limited, Horncastle Street, Cleckheaton, makers of the Panther motor-cycles. Holder of the Territorial Decoration, he commanded the 68th Anti-Tank Regiment R.A. from 1939-41. He was a Justice of the Peace, a former president of the Spen Valley Chamber of Commerce, of the Spen Valley Conservative Association, and of the Spenborough branch of the Royal Society of St. George.

A second tanker of 16,500 tons dw. has been ordered from William Hamilton & Company, Limited, Port Glasgow, by a Greek concern, in place of an original contract for a dry cargo motorship of 10,500 tons dw. The propelling machinery will be supplied by David Rowan & Company, Limited, Glasgow.

The whole interest in Denton & Best & Samuel Swift, Limited, forgemasters and manufacturers of brick-making equipment, of Sheffield, has been acquired by Neepsend Steel & Tool Corporation, Limited, Sheffield. This follows the recent acquisition by the corporation of Sheffield Machine Knife Company, Limited.

Personal

DR. PAUL BASTIEN has been awarded by the *Académie des Sciences* the Mme. V. Nourry prize for his work on metallography.

MR. THOMAS E. SLATER, J.P., of Port Mulgrave, has retired after completing 39 years as a mine manager, of which the last 26 years have been spent in the Cleveland ironstone mines.

MR. F. CARLETON ANDERSON, a founder director of the Harland Engineering Company, Limited, Alloa, has retired. MR. W. SCOTT and MR. L. SPIRO, long-service members of the staff, have been appointed to the board of directors.

MR. LOUIS TONER, structural departmental manager of the Carron Company, Falkirk, retired at the end of the year and was presented with a wallet of notes. Tribute was paid to him by Mr. E. J. Leayer, assistant manager, on his long and successful business career.

MR. C. G. MONK has been appointed director, as from April 1, of the British Non-Ferrous Metals Federation, the headquarters of which are in Birmingham. Mr. Monk was educated at Trinity College, Cambridge and is a barrister. He was for some years secretary to the Chamber of Coal Traders.

MR. C. D. POLLARD of Derby, group general foundry manager of Qualcast Limited, has retired from active participation in the affairs of the company after 17½ years' service. He has also resigned the chairmanship of both Qualcast (Ealing Park) Limited and Qualcast (Wolverhampton) Limited.

The British Thomson-Houston Company, Limited, has announced that MR. F. C. BARFORD, who was formerly manager of the company's Newcastle-upon-Tyne district office, has been appointed manager of the Manchester district office in succession to MR. A. B. RACE, who is retiring after 22 years in that position.

MAIDEN & COMPANY LIMITED, manufacturers of screwing machines, of Hyde, Cheshire, announce that MR. HUGH O. BOURNE has retired from the position of managing director after 42 years' service with the Company. He remains a director and will continue in an advisory capacity. MR. G. BARRIE TINKER has been appointed to the position of general manager.

MR. J. GOFFART, general foundries manager to the well-known firm of S. A. John Cockerill, of Seraing, has been elected president of the Belgian Foundrymen's Association in succession to Mr. Borgerhoff. The new president is well known in this country having been a member of the Institute of British Foundrymen since 1946. Only a few years ago he gave a much appreciated paper to the Institute on the preparation of moulding sand.

THE END OF THE YEAR saw the retirement of one of Head Wrightson & Company, Limited's oldest employees. This was MR. J. W. SCOTT, who had been for many years the company's chief estimator, and who commenced work with the firm in 1887. Mr. Richard Miles, chairman of the company, presented a television set to Mr. Scott which had been subscribed for by the directors and senior staff. Mr. Scott's twin grandsons are now serving as engineering apprentices with the same firm.

SIR ARCHIBALD ROWLANDS, Permanent Secretary to the Ministry of Supply, is retiring from the public service on reaching the age of 60. Sir Archibald has held this appointment since 1946, and has served as a member of the Economic Planning Board since 1947. He will be succeeded by SIR JAMES HELMORE, who was formerly Permanent Secretary to the Ministry of Materials. Formerly a Deputy Secretary in the Ministry of Supply, SIR ERIC BOWYER is appointed Permanent Secretary to the Ministry of Materials.

MR. C. A. PACKER, who for more than thirty years has been responsible for the training of apprentices at the works of G. & J. Weir, Limited, Cathcart, Glasgow, retired at the end of 1952. Presentations were made to him by the directors and staff, the foremen's council, and past and present apprentices. Mr. Packer has supervised the training of more than 3,000 apprentices. Recognition was made of his services to the community when he was made a Member of the Order of the British Empire in the 1952 New Year Honours List.

THE HONORARY DEGREE of Doctor of Science will be conferred on MR. H. H. BURTON, chief metallurgist and a director of English Steel Corporation Limited, at Sheffield University in June. Mr. Burton was made a C.B.E. in the New Year Honours for his work in various committees connected with armaments. He was educated at King Edward VII School, Sheffield, and Sheffield University. He became English Steel Corporation's chief metallurgist in 1934, a special director in 1938, and a director in 1943. He is also a director of Firth-Vickers Stainless Steels Limited, Darlington Forge Limited, and Industrial Steels Limited.

MR. HARRY EYLES who has been secretary of the Birmingham Chamber of Commerce since 1929 is to retire in July or August. He will be succeeded by MR. WILLIAM JOHN LUXTON. During his 34 years in office, Mr. Eyles has assisted in important developments in the work of the Chamber and took a principal part in forming the engineering division of the British Industries Fair. Mr. Luxton is 44, and after taking a Commerce degree at London University was called to the Bar in 1938. Until his appointment in 1947 as Legal and Parliamentary Secretary of the Association of British Chambers of Commerce he was with a firm of wholesale and woollen merchants in London, where he was chiefly engaged on taxation and trade mark problems.

The newly-installed president of the British Association, SIR EDWARD APPLETON, is a distinguished scientist whose achievements in the field of pure and applied physics earned for him in 1947 the award of the Nobel Prize for Physics. Educated at Bradford and St. John's College, Cambridge, where he was scholar and exhibitioner and took the Natural Science Tripos in Physics, Sir Edward served for a while after the 1914-18 war as assistant demonstrator in experimental physics at the Cavendish Laboratory, Cambridge. From 1924 until 1936 he was Wheatstone Professor of Physics at the University of London, and during the three following years Jacksonian Professor of Natural Philosophy at Cambridge. In 1939 and for the 10 following years he was secretary of the Department of Scientific and Industrial Research. He is now principal and vice-chancellor of Edinburgh University.

MR. ARTHUR CROFT, chairman and managing director of Crofts (Engineers), Limited, Bradford, has sailed for South Africa, where he will visit the company's works at Benoni, near Johannesburg. Mr. Croft received a knighthood in the Queen's New Year Honours List.

MR. H. GRINDALL has relinquished his posts as a special director and joint secretary of Metropolitan-Cammell Carriage & Wagon Company, Limited, and Metropolitan-Cammell-Weyman Motor Bodies, Limited, Birmingham, having reached retirement age. MR. C. G. WALLACE succeeds him as secretary of both companies.

News in Brief

PLANS have been approved for the reconstruction of workshops at Bonhay Foundry, Bonhay Road, Exeter.

A BUNKER LEVEL CONTROL has been developed by Radiovisor Parent Limited, of 1, Stanhope Street, London, N.W.1.

RE-ELECTED secretary of the Birmingham and District branch of the Amalgamated Engineering Union, MR. F. W. CROWDER enters upon his second year of office.

THE NUMBER of Midland workers on short time, which fell to 9,263 before Christmas, rose to 16,288 at the end of the week ended January 3. Shortage of steel is stated to be the cause of much of this.

BIRLEC LIMITED, Erdington, Birmingham, have issued a well-illustrated 20-page booklet recording the various events organized in connection with the silver jubilee celebrations of the company.

AT THE MEETING of the Kidderminster and District Employment Committee on January 7, it was reported that about 100 men engaged in the manufacture of steel sheet at Stourport, are working short time.

ONE HUNDRED EMPLOYEES of J. A. Phillips & Company, Limited, the Smethwick cycle firm, were declared redundant from January 9. The majority of the workers given notice are from the firm's Bridge Street works.

A BOOKLET issued by the Institute of Cost and Works Accountants, 63, Portland Place, London, W.1, announces the creation of a fellowship award and the syllabus which forms the basis for the examination of candidates.

A DESIGN SERVICE to demonstrate to founders the equipment required to convert jobs for manufacture by shell-moulding techniques has been inaugurated by B. Levy & Company (Patterns), Limited, Osbert Street, London, S.W.1.

AMONGST the ten recipients of gold watches presented to those having 50 years' service with the Glanmôr Foundry, Limited, and Thomas and Clement, Limited, was Lt.-Col. H. C. R. Thomas who was a director from 1925 to 1945.

EMPLOYEES of Ley's Malleable Castings Company, Limited, and the Ewart Chainbelt Company, Limited, Derby, this Christmas received £62,000, under the rules of the companies' profit-sharing scheme which was inaugurated in 1919 by the late Sir Gordon Ley, Bart.

MR. DUNCAN SANDYS, Minister of Supply, visited the Coneygre Foundry, Tipton, on January 7, when a souvenir brochure was presented to him. The Minister complimented the Coneygre concern on the fine conditions of working which he had seen there.

BAMFORD LIMITED, agricultural machinery manufacturers of Uttoxeter, are listed among the tradesmen in the department of Her Majesty's Privy Purse permitted to style themselves "By appointment to the late King George VI" entitling them to display the Royal Arms.

THE BRITISH INSTITUTE OF MANAGEMENT has issued an advance programme for a conference for small firms on "Making the Most of Limited Resources" to be held at Ashorne Hill, near Leamington Spa, Warwickshire, from February 13 to 15. Particulars of the arrangements may be obtained from the Institute at 8, Hill Street, London, W.1.

THE ALUMINIUM DEVELOPMENT ASSOCIATION, 33, Grosvenor Street, London, W.1, have just issued Information Bulletin No. 20 "Painting Practice for Aluminium" (price 2s.) which records significant advances in recent practice and deals with cleaning and degreasing, pre-treatment where necessary, the choice of paint system (divided between single-coat systems and multi-coat systems) and the repainting of various components and structures.

FIVE STUDENTS of the University of Cape Town Engineering and Scientific Society arrived in Birmingham on January 12 in order to study local industry. They are to visit, among other factories, the steel works of Stewarts and Lloyds Limited; Fisher and Ludlow Limited; Chance Bros. glass-works and the Quasi-Arc Company at Bilston. They were guests of the Birmingham Chamber of Commerce at a reception and dinner on the first day of their visit.

WICKMAN LIMITED announce that their interests in industrial high-frequency heating equipment previously operated as a separate subsidiary business under the name of Applied High Frequency Limited, was, from January 5, changed to a division of the company under the title of Wickman Limited, Applied High Frequency Division. The address of the new division is the same as that of the previous concern, namely Actarc Works, Goldhawk Road, London, W.12.

THE BRITISH PRODUCTIVITY COUNCIL is sponsoring a specialist team on industrial engineering to visit and report upon American methods. The leader is Mr. W. F. Garnham, general works manager, Ransomes Sims & Jefferies Limited, and other members include Mr. T. Baylis, works manager, Sir W. G. Armstrong Whitworth Aircraft Limited, Mr. E. F. Grunow, planning engineer, Baker Perkins Limited, Mr. W. M. Rodgers, principal scientific officer, Department of Scientific and Industrial Research, and Mr. E. W. Workman, costs and accounts controller, Morgan Crucible Company, Limited.

THE ZINC ALLOY DIE CASTERS ASSOCIATION, Lincoln House, Turl Street, Oxford, announce that following the publication in October of the zinc and aluminium die-casting productivity report by the Anglo-American Council on Productivity, arrangements have been made to hold meetings in London and Birmingham to discuss the main findings of the team. Representatives of both sections will be present at the meetings to discuss the issues raised by the report and to answer questions, and it is anticipated that the meetings will both be lively ones. The London meeting will be on January 23, at 6.30 p.m. in the Northampton Polytechnic, St. John Street, E.C.1, and the Birmingham meeting on January 28, at 6.30 p.m. in the College of Technology, Suffolk Street, Birmingham 1. Anyone interested in die-casting can attend either meeting.

BIRMINGHAM ALUMINIUM CASTING COMPANY, LIMITED, the first of the companies to be founded in the Birmid Industries combine, celebrates its golden jubilee this year, and the directors are arranging an ambitious programme to commemorate this event, which happily falls in Coronation Year. May 30 is to see a monster outing to London of all the firm's manual employees, who will be transported by a fleet of special buses. Other items in the celebrations include a staff dance at the Grand Hotel, Birmingham, a dinner at the Botanical Gardens, Birmingham for firms' long-service employees, and a special brochure. The firm was founded in small premises in Cambridge Street, Birmingham, and was one of the earliest aluminium foundries in this country. Much of its rapid development was due to the late Mr. Percy Pritchard who died in 1945. Beginning with only a small number of operatives, the firm now employs approximately 1,500.

Raw Material Markets

Iron and Steel

The expectation that the new blast furnace at Shotton would be in active service before the end of 1952 was not fulfilled, but the aggregate output of pig-iron for the past year will nearly approach 11,000,000 tons and may be increased by another 1,000,000 tons during 1953. This, in fact, is the starting point of the steel industry's ambitious programme of expansion. More pig-iron will reduce the steelmakers' dependence upon precarious scrap supplies from abroad. The needs of the foundry trade also call for more liberal supplies of pig-iron. No. 3 iron is relatively cheap, the price being left unchanged when higher rates were authorized for other grades. This concession will, it is hoped, give some impetus to the light-castings trade, which has not been particularly brisk of late. There is, however, a pressing demand for hematite and low-phosphorus iron, which is needed in bigger quantities by the engineering and speciality foundries.

During the greater part of 1952 re-rollers were kept in a state of constant anxiety owing to the shortage of steel services. Reserves were at all times inadequate and not infrequently mills were stopped through lack of material. The position is now easier. Deliveries from British steelworks have improved and a slow-down of imports can be envisaged. Purchase of foreign material is, of course, in the hands of the British Iron and Steel Corporation, whose contractual obligations for the current year are already extensive.

Without openly dissenting from the prevailing opinion that more recently competitive conditions are developing in world markets, steelmakers entertain no apprehensions of any decline in the demand for the main finished products. Although other European countries, as well as the United States, are expanding outputs, they are not within sight of a state of equilibrium between supply and demand. British steelmakers begin the year with full order-books and every incentive to force up production to still higher levels. There is no abatement of the pressure for prompt deliveries, and in spite of all the restrictions on foreign trade, shipments of material to overseas destinations are also improving.

Non-ferrous Metals

As was anticipated, November has turned out to be rather a poor month for consumption of non-ferrous metals, at any rate in comparison with October, and the chances are that when the December figures are published we shall find a further decline in the tonnage used. Consumption of copper, virgin and scrap, in November, amounted to 45,675 tons, compared with 51,578 tons in October. Stocks increased, the comparison being between 126,394 tons at November 30 and 119,052 tons at the end of October. To the end of November the country had absorbed 535,633 tons of copper, a gain of about 25,000 tons over the same period in 1951. Stocks of lead dropped by some 5,600 tons to 101,570 tons, while consumption, all grades, at 26,996 tons, was about 2,000 tons down. For the 11 months to November 30, usage was nearly 27,000 tons. In zinc, stocks increased by nearly 10,000 tons to 152,129 tons, of which only 8,000 tons were held by the consumer. Consumption of virgin and secondary zinc at 19,570 tons compared with 22,264 tons in October, and for the 11 months the advancing total was 237,348 tons, about 22,000 tons down on 1951. Consumption of tin in November was 1,826 tons, a drop of 240 tons on the previous month.

Encouraged doubtless by the price trend in London, the U.S. zinc quotation advanced last week by 50 points to 13 cents. Lead, however, moved in the opposite direction, for the chief Custom smelter reduced its selling price by 25 points to 14½ cents, without, it would appear, attracting a great deal of business. In spite of special support from time to time afforded to the zinc and lead markets in London, those metals have been showing a somewhat drooping tendency of late, for consumers do not seem to be very keen on buying, and are apparently sticking to a hand-to-mouth policy.

The copper price is very steady at around 35 cents f.a.s. New York, while a recent report from Chile states that the Central Bank there, now handling the marketing of the country's copper production, has sold 265,783 tons at 35.5 cents per lb. between May and November 15 last year. No doubt a large proportion of this was sold to the United States, but not necessarily all of it. Hopes are entertained that copper trading on the London market may start this year, but nothing definite is known.

Official zinc prices:—

January—January 8, £89 5s. to £89 10s.; January 9, £91 10s. to £92; January 12, £90 10s. to £91; January 13, £86 10s. to £87 5s.; January 14, £90 10s. to £91.

April—January 8, £88 5s. to £88 10s.; January 9, £90 15s. to £91; January 12, £90 to £90 5s.; January 13, £86 10s. to £87; January 14, £90 5s. to £91.

Official prices for refined pig-lead:—

January—January 8, £97 to £98; January 9, £100 10s. to £101 10s.; January 12, £100 to £100 10s.; January 13, £96 10s. to £97; January 14, £96 10s. to £97.

April—January 8, £94 5s. to £94 10s.; January 9, £97 15s. to £98; January 12, £96 10s. to £96 15s.; January 13, £93 10s. to £94; January 14, £94 to £94 10s.

Official tin quotations:—

Cash—January 8, £944 to £945; January 9, £950 10s. to £951 10s.; January 12, £952 to £955; January 13, £956 to £958; January 14, £956 to £957.

Three Months—January 8, £936 10s. to £937 10s.; January 9, £941 10s. to £942; January 12, £939 to £942; January 13, £941 10s. to £942; January 14, £942 to £943.

Tungsten Distribution Plans Discontinued

The tungsten-molybdenum committee of the International Materials Conference has announced that member Governments have accepted its recommendation to discontinue international distribution plans for tungsten after December 31 last. This action has been permitted by the consistent improvement in the tungsten supply situation, together with the return of easier market conditions. The committee will, however, continue to keep the supply and demand position under review.

The 13 countries represented on the tungsten-molybdenum committee are Australia, Bolivia, Brazil, Canada, Chile, France, the Federal Republic of Germany, Japan, Portugal, Spain, Sweden, the United Kingdom, and the United States.

Selling Price Reduced

The selling prices for tungsten ores of standard 65 per cent. grade and ordinary quality have been reduced by the Ministry of Materials as from January 8. Wolframite has been reduced from 432s. 6d. to 392s. 6d. and scheelite from 422s. 6d. to 382s. 6d. per long ton unit delivered consumers' works.

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

(Delivered, unless otherwise stated)

January 14, 1953

PIG-IRON

Foundry Iron.—No. 3 Iron, Class 2:—Middlesbrough, £13 1s. 6d.; Birmingham, £12 15s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £16 8s., 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, £15 5s. 9d.

Scotch Iron.—No. 3 foundry, £15 19s. 6d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £17 14s. 6d. South Zone, £17 17s.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £18 14s. 6d.; South Zone, £18 17s.

Cold Blast.—South Staffs, £18 2s.

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 2s.; Scotland (Scotch iron), £16 8s. 6d.; Sheffield, £17 3s.; Birmingham, £17 9s. 6d.; Wales (Welsh iron), £16 8s. 6d.

Basic Pig-iron.—£13 19s. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered.)

Ferro-silicon (6-ton lots).—40/55 per cent., £57 10s., basis 45% Si, scale 21s. 6d. per unit; 70/84 per cent., £86, basis 75% Si, scale 23s. per unit.

Ferro-vanadium.—50/60 per cent., 22s. to 28s. 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%, £235 to £265 per ton.

Ferro-tungsten.—80/85 per cent., 25s. 3d. to 25s. 9d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 28s. 3d. to 32s. 7d. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent. C, £85 4s., basis 60% Cr, scale 28s. 3d. per unit; 6/8 per cent. C, £80 17s., basis 60% Cr, scale 26s. 9d. per unit; max. 2 per cent. C, 2s. 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.

Ferro-manganese (blast-furnace). — 78 per cent., £48 12s. 11d.

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

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

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—Basic: Soft, u.t., £25 4s. 6d.; tested, 0.08 to 0.25 per cent. C (100-ton lots), £25 14s. 6d.; hard (0.42 to 0.60 per cent. C), £27 12s.; silico-manganese, £33 8s.; free-cutting, £28 8s. 6d. Siemens Martin Acid: Up to 0.25 per cent. C, £31 9s.; case-hardening, £31 17s.; silico-manganese, £34 9s. 6d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £29 8s.; basic, hard, over 0.41 up to 0.60 per cent. C, £30 8s.; acid, up to 0.25 per cent. C, £31 17s.

Sheet and Tinplate Bars.—£25 3s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £29 14s.; boiler plates (N.-E. Coast), £31 1s. 6d.; chequer plates (N.-E. Coast), £31 3s.; heavy joists, sections, and bars (angle basis), N.-E. Coast, £27 17s.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £31 15s. 6d.; flats, 5 in. wide and under, £31 15s. 6d.; hoop and strip, £32 10s. 6d.; black sheets, 17/20 g., £41 12s. 6d.; galvanized corrugated sheets, 24 g., £52 9s.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £50 18s. 3d.; nickel-chrome, £71 7s. 9d.; nickel-chrome-molybdenum, £79 2s. 6d.

Tinplates.—57s. 1½d. per basis box.

NON-FERROUS METALS

Copper.—Electrolytic, £285; high-grade fire-refined, £284 10s.; fire-refined of not less than 99.7 per cent., £284; ditto, 99.2 per cent., £283 10s.; black hot-rolled wire rods, £294 12s. 6d.

Tin.—Cash, £956 to £957; three months, £942 to £943; settlement, £957.

Zinc.—January, £90 10s. to £91; April, £90 5s. to £91.

Lead.—Refined pig-lead: January, £96 10s. to £97; April, £94 to £94 10s.

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £114 10s.; rolled zinc (boiler plates), all English destinations, £112 10s.; zinc oxide (Red Seal), d/d buyers' premises, £—

Other Metals.—Aluminium, ingots, £166; magnesium, ingots, 2s. 10½d. per lb.; antimony, English, 99 per cent., £225; quicksilver, ex warehouse, £70 10s. to £71 (nom); nickel, £483.

Brass.—Solid-drawn tubes, 26¾d. per lb.; rods, drawn, 37d.; sheets to 10 w.g., 291s. per cwt.; wire, 32⅞d.; rolled metal, 277s. 9d. per cwt.

Copper Tubes, etc.—Solid-drawn tubes, 32¾d. per lb.; wire, 317s. 9d. per cwt. basis; 20 s.w.g., 346s. 3d. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £195 to £218; BS. 1400—LG3—1 (86/7/5/2), £205 to £238; BS. 1400—G1—1 (88/10/2), £320 to £375; Admiralty GM (88/10/2), virgin quality, £325 to £380 per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £350 to £385; L.P.Bl, £250 to £275 per ton.

Phosphor Bronze.—Strip, 413s. 3d. per cwt.; sheets to 10 w.g. 435s. per cwt.; wire, 49⅝d. per lb.; rods, 44½d.; tubes, 42¾d.; chill cast bars: solids 4s., cored 4s. 1d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Ingots for raising, 2s. 9d. per lb. (7%) to 3s. 10½d. (30%); rolled metal, 3 in. to 9 in. wide × .056, 3s. 3d. (7%) to 4s. 4¼d. (30%); to 12 in. wide × .056, 3s. 3½d. to 4s. 4½d.; to 25 in. wide × .056, 3s. 5½d to 4s. 6½d. Spoon and fork metal, unsheared, 3s. 0d. to 4s. 1½d. Wire, 10g., in coils, 3s. 9½d. (10%) to 4s. 10½d. (30%). Special quality turning rod, 10%, 3s. 8½d.; 15%, 4s. 1½d.; 18%, 4s. 6½d. All prices are net.

Forthcoming Events

JANUARY 16

Institute of British Foundrymen

Tees-side branch:—"Notes on Patternmaking," by H. Wilson, 7.30 p.m., at Head, Wrightson & Company, Limited, Teesdale Ironworks, Thornaby-on-Tees.

Incorporated Plant Engineers

Birmingham branch:—Contractors' Plant Discussion Group, 7.30 p.m., at the Imperial Hotel.

JANUARY 19

Sheffield Society of Engineers and Metallurgists

"Application of the Diesel Engine and the Gas Turbine to Traction," by G. H. Fletcher, 7.30 p.m., in the University Building, St. George's Square.

Institution of Production Engineers

Derby section:—"Mechanical Handling," by J. Carruthers and R. M. Williams, 7 p.m., at the College of Art, Green Lane, Derby.

JANUARY 20

Institute of British Foundrymen

East Anglian section:—"The Sacred Fire," film on loan from *L'Association Technique de Fonderie*, 7 p.m., at the Central Hall, Public Library, Ipswich.

Coventry and district students' section:—"Metallurgy of Cast Iron," by Dr. R. V. Riley, 7.15 p.m. at Coventry Technical College (Room A5).

Sheffield Metallurgical Association

Annual general meeting and presidential address, 7 p.m., in the Grand Hotel.

Institution of Works Managers

Birmingham branch:—"Line Flow Production in Industry," by F. G. Woollard, 7 p.m., in the Grand Hotel.

Institution of Production Engineers

Manchester graduate section:—"The Work of the N.P.L. (Metrology Division)" by J. Parker, 7.15 p.m., at The Reynolds Hall, (Room C3), College of Technology, Sackville Street.

Oxford sub-section:—"Compressed Air Technique and some of its Practical Applications," by W. J. Ford, 7.15 p.m., at the Apprentice School, Morris Motors Limited, Holloway Way, Cowley.

Wolverhampton graduate section:—"Refrigeration," by J. G. Adamson, 7.30 p.m., at the Star and Garter Royal Hotel Victoria Street.

Incorporated Plant Engineers

Hertfordshire discussion group:—"Colour in Industry," by R. E. Wilson, 7.30 p.m., at the Peahen Hotel, St. Albans.

JANUARY 21

Institute of British Foundrymen

East Midlands branch:—"System of Studying Casting Defects," by G. W. Nicholls and D. T. Kershaw, 6 p.m., at the College of Arts and Crafts, Derby.

Institute of Vitreous Enamellers

Northern section:—"Correct Choice of Frits for Vitreous Enamelling," by H. Laithwaite, at the Grand Hotel (instead of the Queen's Hotel), Manchester.

Southern section:—Discussion forum, 7.15 p.m., at the Howard Hotel, Norfolk Street, Strand, London, W.C.2.

Institute of Metals

London local section:—"Analysis of Metals by Spectroscopy," by A. C. Menzies. (Joint meeting with the local sections of the Society of Chemical Industry and the Royal Institute of Chemistry.) 7 p.m. in the large Chemistry Theatre, University College, Gower Street, W.C.1.

Incorporated Plant Engineers

Western branch:—"Approach to Maintenance." Discussion of the report of the Productivity Team's visit to U.S.A., by Colin Troup, 7.15 p.m., in the Grand Hotel, Bristol.

Institution of Production Engineers

South Essex sub-section:—"Modern Electroplating and Metal-finishing Processes," by H. Cann, 7.30 p.m., at the Ilford Bowling Club.

JANUARY 23

Institute of British Foundrymen

Birmingham branch:—Annual dinner and dance, 7 p.m. at the Botanical Gardens, Edgbaston.

Association of Bronze and Brass Founders

Yorkshire area:—Meeting of members in the area will be held in Leeds at the Great Northern Hotel commencing with luncheon at 12.30 p.m.

Institution of Mechanical Engineers

"Design of Precision Grinding Machines," by G. H. Ashridge, 5.30 p.m., at Storey's Gate, St. James's Park, London, S.W.1.

JANUARY 24

Institute of British Foundrymen

Bristol and West of England branch:—"Mechanical Aids in the Foundry," by J. Blakiston, 3 p.m., at the Grand Hotel, Bristol.

Institution of Production Engineers

Yorkshire graduate section:—Works visit to David Brown Tractors (Engineering) Limited, Farsley, Leeds, 9.30 a.m.

NOTICE

Replies to Box Numbers to be addressed to "Foundry Trade Journal," 49, Wellington Street, London, W.C.2.

SITUATIONS WANTED

FOUNDRY TECHNICIAN / METALLURGIST, young, energetic, desires progressive position. Able to take charge laboratory technical control, high duty irons, sand and cupola control, experience all departments, mechanisation. Production minded. Final C. & G. Foundry Practice. Midlands preferred.—Box 3197, FOUNDRY TRADE JOURNAL.

FOUNDRY ENGINEER, twenty seven years' experience in Canada, U.S.A. and England. Possess drive and initiative to organise and control the maintenance and developments of building plant layout. Knowledge of mechanisation, continuous pouring up to one hundred tons per day.—Box 3176, FOUNDRY TRADE JOURNAL.

EXECUTIVE, Non-Ferrous Foundries, accustomed to complete control, seeks progressive position. Sound technical and practical experience of hand and mass production methods of heavy and light castings to specification. Available shortly. — Box 3181, FOUNDRY TRADE JOURNAL.

FOUNDRY GENERAL MANAGER (45), M.I.B.F., A.M.I.P.E., Inter. B.Sc. (Eng.), specialist air-cooled cylinder production, repetition full and semi-mechanised plants, extensive knowledge C process, phenol and urea resins, etc., accustomed take full control all depts., rigid metal, sand, control, commercial, sales, excellent connections trade, salary envisaged on results basis £1,500-£2,000, wishes join small Midland foundry (grey, high duty, malleable or non-ferrous), desiring organisation and development.—Box 3192, 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.

FOREMAN for small Patternshop servicing Mechanised and Jobbing Foundries. Staff appointment. Apply in first instance by letter, giving age, full particulars of experience and salary required; also name and address of two references. All applications will be treated in strict confidence.—RICHARDS (LEICESTER), LTD., Phoenix Iron Works, Leicester.

METALLURGIST, age about 25/35, to take charge of laboratory and technical control in progressive Cylinder Foundry in Watford, Herts. Candidates should possess initiative and be production minded.—Write, giving details of age and experience, to MACMILLAN FOUNDRIES, LTD., Cassiobury Mills, St. Albans Road, Watford.

WANTED—Metallurgist for laboratory of small Steel Foundry in Sheffield Area operating high-frequency furnaces. Able to conduct simple analysis, sand control, furnace control melting and heat-treatment.—Write stating experience and salary required, etc., to Box 3188, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

REPRESENTATIVE for Heat Treatment Furnaces and Foundry Drying Equipment, for Scotland. Salary plus commission offered.—Box 3174, FOUNDRY TRADE JOURNAL.

PATTERNMAKER.—Wanted by a large firm of Electric Range and Gas Stove manufacturers in Australia, a first-class Patternmaker with experience in tin, plaster and wood patternmaking. £A15 15s. 6d. p.w.—Apply, stating age and experience to Box 3187, FOUNDRY TRADE JOURNAL.

TIME STUDY RATE FIXER for re-costing, etc., required for Machine Shop, Mechanised and General Iron Foundry. Progressive position for man with plenty of drive and able to work on own initiative. Only man fully experienced need apply. — Box 3185, FOUNDRY TRADE JOURNAL.

DRAUGHTSMAN required for Foundry (both Mechanised and General) also Machine Shop, Drop Forge, etc.; must be fully experienced in every way in reading blue prints, estimating weights, and work on drawing board, able to work on own initiative.—Box 3183, FOUNDRY TRADE JOURNAL.

REPRESENTATIVES for Firm of Foundry Plant Manufacturers:—

(*a*) Experienced SALESMAN, resident in and for the Home Counties.

(*b*) Young SALESMAN, to train for permanent position, resident and to work in the Midlands territory, and one similar for the Sheffield district.

Apply, giving details of training and experience, positions held and salary. For all three vacancies it would be an advantage for applicants to have some knowledge of Foundry practice.—Box 3191, FOUNDRY TRADE JOURNAL.

WORKS MANAGER for large Light Castings Foundry, manufacturing Stoves, Grates and Cookers for solid fuel and gas. Previous executive experience in foundry producing light ferrous castings required. Must be well acquainted with modern methods of production and experienced in controlling labour—able to take full charge of foundry, pattern shop and assembly shops.—Write, stating age and full details of experience, to FORTH & CLYDE & SUNNYSIDE IRON COS., LTD., Falkirk.

A METALLURGICAL or Mechanical Engineer Graduate, age about 30, required as SALES REPRESENTATIVE for Steel Castings in the Midland and Southern District. Successful applicants may be required to work on the shop floor for 12 months to ensure practical knowledge before taking over sales duties. Staff Superannuation Scheme. — Applications, stating age, experience, etc., should be sent to the PERSONNEL SUPERINTENDENT, K. & L. Steelfounders & Engineers, Ltd., Letchworth, Herts.

THE BRITISH CAST IRON RESEARCH ASSOCIATION has a vacancy on its research staff for an investigator for the determination of solidification sequences in cast iron by temperature gradient measurements as part of an investigation on the soundness of iron castings. Applicants should possess an honours degree or its equivalent, and some previous research and/or industrial experience would be an advantage. The appointment will be in the Scientific Officer (£418—£676 per annum) or Senior Scientific Officer (£785—£890 per annum) grade according to age, experience and qualifications. Applicants should submit full details of qualifications, age and experience to the BRITISH CAST IRON RESEARCH ASSOCIATION, Alvechurch, Birmingham.

SITUATIONS VACANT—*Contd.*

FOREMAN for Foundry producing Grey Iron Castings. Will be in full charge of about 20 men.—Apply in confidence J. J. SMITH & CO. (ENGINEERS) LTD., Waddicar Lane, Melling, Near Liverpool.

DEPUTY FOREMAN PATTERNMAKER required for Australian light casting foundry. Experience in domestic cooking appliances trade an advantage. Must have experience in tin, plaster and wood. £A18 p.w. (Staff).—Apply, stating age and experience to Box 3186, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN required for Shift Work in a Non-Ferrous Foundry West of London. Excellent conditions and opportunities for right man. State age and full details of Experience to Box 3194, FOUNDRY TRADE JOURNAL.

ASSISTANT FOUNDRY MANAGER required for modern mechanised Brass Foundry. Excellent opportunity for young man with good experience of moulding.—Apply SHIPMAN & CO., LTD., Hawthorn Avenue, Hull.

TECHNICAL SALESMAN required by prominant manufacturers of Core Binders to consolidate and develop further their business in Lancashire and Yorkshire. Full knowledge of Foundry and Core Shop practices essential. Applicants must be resident in Lancashire or Yorkshire.—Write, giving full details of experience, to Box 3172, FOUNDRY TRADE JOURNAL.

REPRESENTATIVE, with established connection, already calling on engineering and allied trades, required by firm of Non-ferrous Founders to introduce their Castings as an additional line, and obtain business on part salary and commission basis. Full particulars, stating area covered and other lines already carried.—Box 3152, FOUNDRY TRADE JOURNAL.

BLACKHEART MALLEABLE and Grey Iron Foundry requires a Representative, aged about 30-35, with experience in the industry and live connection with consumers of these materials, residing in Lancashire, Yorkshire or Northumberland, to cover these areas.—Write, stating full details of experience and salary required, to Box 3175, FOUNDRY TRADE JOURNAL.

MELTING SHOP METALLURGIST required, age 25/30 years, for Iron and Steel Foundry in South Yorks. Conversant with Cupola/Converter practice essential, and a working knowledge of the production of high-grade irons desirable. Applicant will serve as Assistant to the M/Shop Superintendent, and the position will provide plenty of scope for a keen worker.—Apply, in confidence, to Box 3167, FOUNDRY TRADE JOURNAL.

ALLIED IRONFOUNDERS, LTD., invite applications for the post of WORKS MANAGER at their Bath Plant, Greenford (Middx.). Applicants must have first-class qualifications and experience in ironfounding, foundry mechanisation, and modern mass production methods, and be competent to accept full responsibility for the operation and development of modern works. Knowledge of enamelling on cast iron will be an advantage. Good salary and permanent position offered to the right man.—Please address replies to THE SECRETARY, British Bath Co., Ltd., Greenford, Middx.

AGENCIES

AGENT REQUIRED FOR SCOTLAND BY CORE-BINDER MANUFACTURERS.—Box 3184, FOUNDRY TRADE JOURNAL.

AGENCIES—*Contd.*

MODERN fully mechanised Malleable Foundry in Midlands requires SALES AGENT to cover Lancs and Yorks area. Must have practical Foundry experience and good contacts.—Box 3138, FOUNDRY TRADE JOURNAL.

AGENCY.—Sales Agent required by Iron Founders in Yorkshire. Good commission payable to man able to introduce business.—Box 3193, FOUNDRY TRADE JOURNAL.

PATENTS

THE PROPRIETOR of British Patent No. 629248, entitled "Improvements in and connected with the casting of metal," offers same for licence or otherwise to ensure practical working in Great Britain.—Inquiries to SINGER, STERN & CARLBERG, 14 East Jackson Boulevard, Chicago 4, Illinois, U.S.A.

BUSINESS FOR SALE

ENGINEERING & IRON FOUNDRY BUSINESS FOR SALE at Misterton, Notts, 17 miles from Doncaster, owing to sudden death of Governing Director. Old established business converted in 1939 into private limited company. Tenancy or purchase of freehold premises.—For details apply ALDAM (MISTERTON) LIMITED, Doncaster. (Telephone: Misterton 236.)

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BROOM & WADE type EH.251 or Ingersoll Rand Air compressor. 495. CFM. 100 lbs. W.P. 310 R.P.M. water cooled 112 H.P. 400/3/50 motor and after cooler.—Write PRIORFIELDS FOUNDRY CO., LTD., Spring Road, Ettingshall, Wolverhampton.

CORE Sand Mixer, 1 or 2 cwts. capacity, wanted.—BISON FOUNDRY, West Grinstead, Sussex. Tel.: Cowfold 310.

WANTED.—GAS FIRED MUFFLE FURNACE. Approximate size 6 ft. deep. 2 ft. high, 5 ft. wide. Working temperature 500/800 degrees Centigrade. Thermostatic control.— H. B. BARNARD & SONS, LTD., Dudley Port, Tipton.

PLANITOR GRINDER, or similar new or good secondhand machine, minimum diameter of wheel 24 in., complete with dust extraction fan and motor, suitable for 440 volts, 3-phase, 50 cycles.—Please state price and where seen to SMITH & WELLSTOOD, LTD., Ironfounders, Bonnybridge, Scotland.

MACHINERY FOR SALE

GAS-FIRED STOVES, 6 ft. by 6 ft. by 6 ft. and 8 ft. 6 in. by 4 ft. by 7 ft. —Box 3196, FOUNDRY TRADE JOURNAL.

FOR SALE.

NO. 16 ATRITOR CRUSHER by Alfred Herbert, complete with Feed Hopper, overhauled and with a quantity of spares. Also a No. 12 Atritor by Alfred Herbert, for which we have available about 6 tons of spares. Both these machines are offered at extremely low prices for quick clearance.

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MACHINERY FOR SALE—*Contd.*

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SIZE 15 PADDLE BLADE FAN, 2,000 c.f.m. against 6 in. w.g., 5 h.p. s.c. motor, 400/3/50, outlet 9½ in. by 8 in., inlet 9 in. dia.

SIZE 17 PEERLESS EXHAUST FAN, capacity 6/7,000 c.f.m., 5 in. w.g., 10 h.p. s.c. motor, 400/440/3/50. Starter, slide rails, 17 in. inlet, outlet 12 in. by 15 in.

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Our new Catalogue would interest you. May we send you a copy—free.

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MACHINERY FOR SALE—*Contd.*

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FOR SALE two half tonner (1952) Jolt Rollover Pneulec Machines, complete with spare Bumping Unit. Also four 750 lb. Jolt Rollover Pneulec Machines.—Write CATTON & COMPANY LTD., 29, Chadwick Street, Leeds, 10.

B.T.H. very powerful Dust Extractor-Blower. Motorised unit (unused), £15. One-third to-day's cost.—BELLANGER'S, 306, Holloway Road, London, N.7. North 4117.

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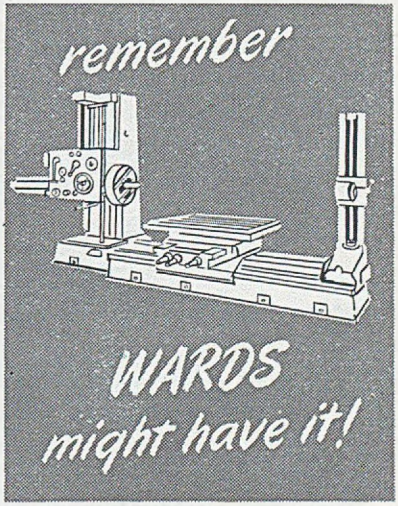

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100 K.W. Steam-driven Alternator Set, 400/440 volts, 3 phase, 50 cycles, Bellis & Morcom engine, 150 p.s.i.; also Two 250 K.W. Steam-driven Alternator Sets, 150/160 p.s.i. Enquiries invited for all types of Electrical and other machinery.—REES INDUSTRIES LTD., Great Western Dock, Llanelly. Tel.: 657.

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AIR COMPRESSORS.

215-C.F.M., C.P.T., class PB4, vert., 2 stage, air cooled, 100 lb. w.p., speed 870 r.p.m. "V" belt driven from 50-h.p. S/R. Motor, by Higgs, 400-440/3/50, with Control Gear.

200-c.f.m., BROOM & WADE, vert., encl., twin cyl., 2 crank, single stage, water-cooled, 100 lb. w.p., speed 350 r.p.m. "V" belt driven from 43-h.p. S.C. Motor, by L.D.M., 415/3/50, with Control Gear.

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Two 130-c.f.m., TILGHMAN, type FC4E, vert., high speed, single stage, double acting, watercooled, speed 400 r.p.m., w.p. 30 lb. "V" belt driven by 17-h.p. B.T.H. Motor, 400/3/50.

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CAPACITY AVAILABLE—*Contd.*

IRON FOUNDRY Capacity Available on Jobbing Floor and in Moulding Machine Shop for large and small castings.—MANLOVE, ALLIOTT & CO., LTD., Bloomsgrove Works, Nottingham.

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BEEHIVE FOUNDRY, 50, Hall Lane, Walsall Wood, Staffs, for small to medium Sand Castings in all Aluminium Alloys. We specialise in all types of Aluminium Plates and Bottom Board for foundry use.

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NON-FERROUS FOUNDRY. — First-class quality castings in Aluminium, Bronze, Gunmetals, etc., at competitive prices, including patterns if required.—BEESTON LEE & CO., LTD., 33, Swindon Road, Stratton St. Margaret, Wilts.

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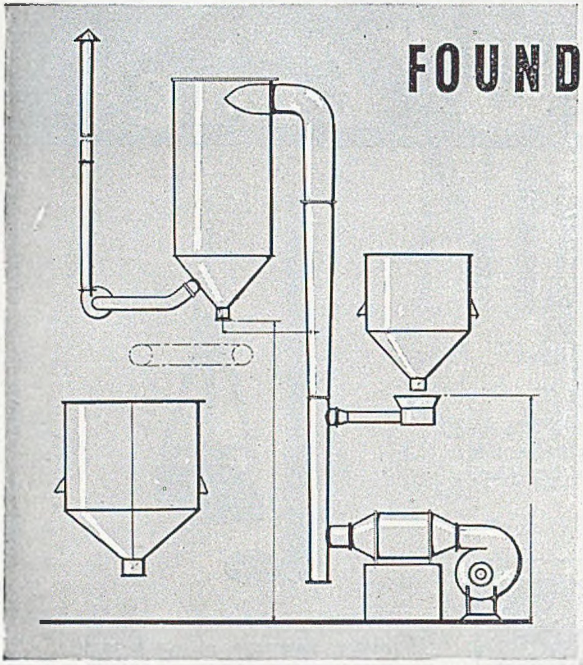

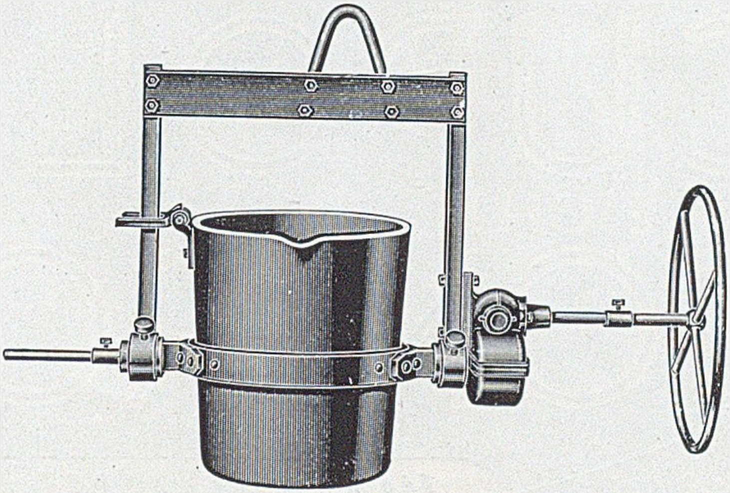

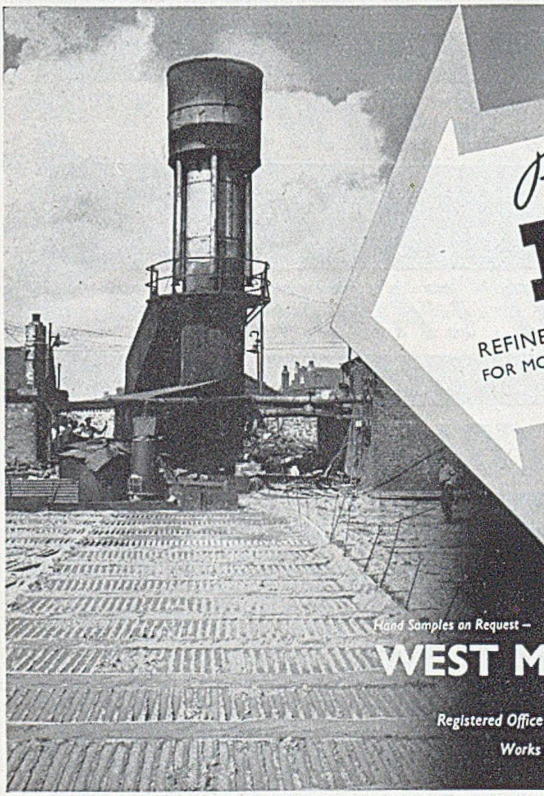

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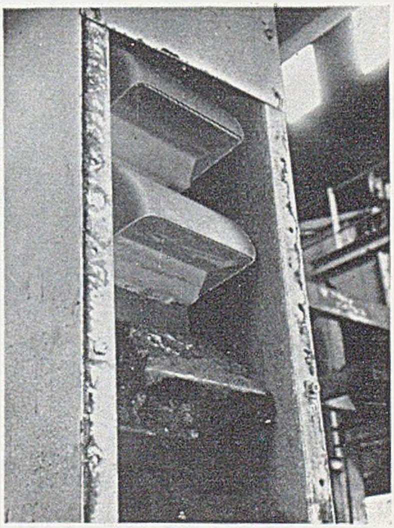

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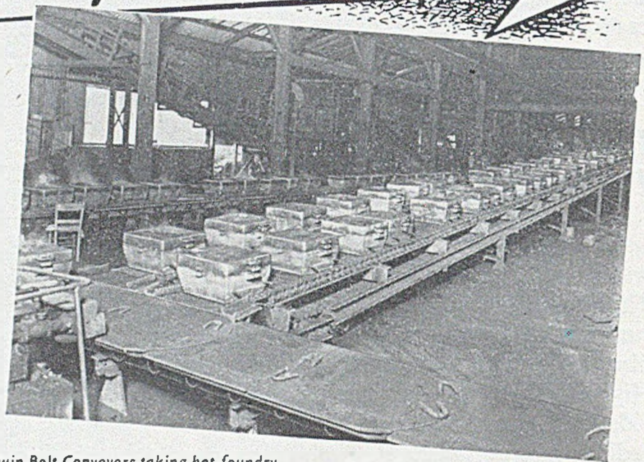

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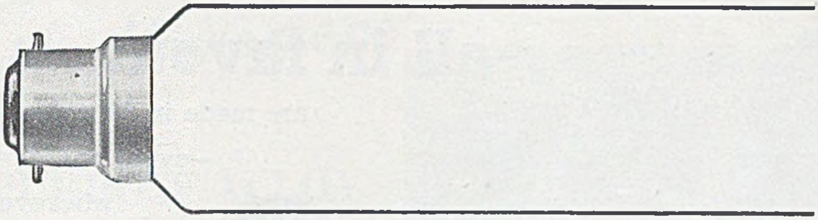

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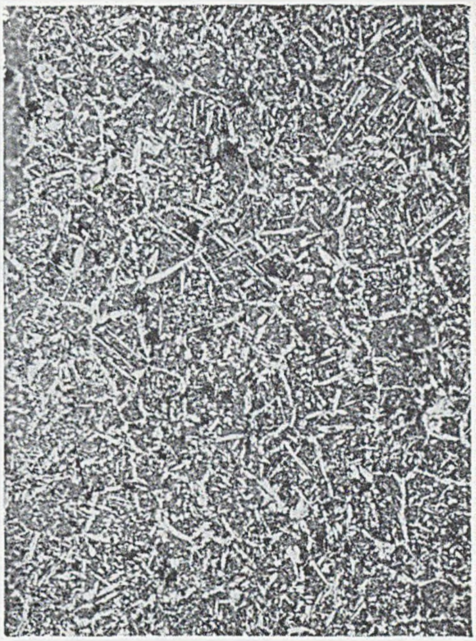

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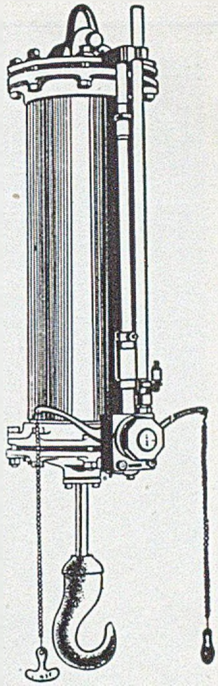

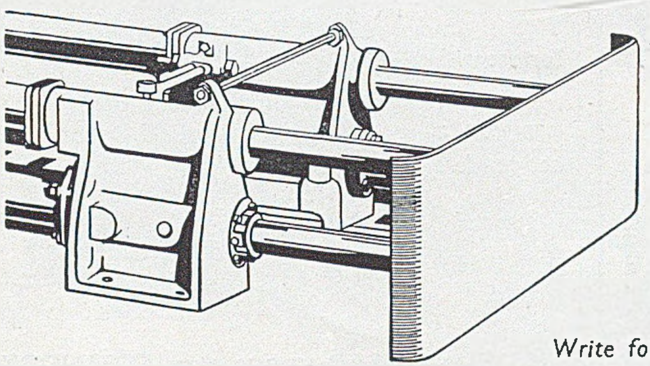

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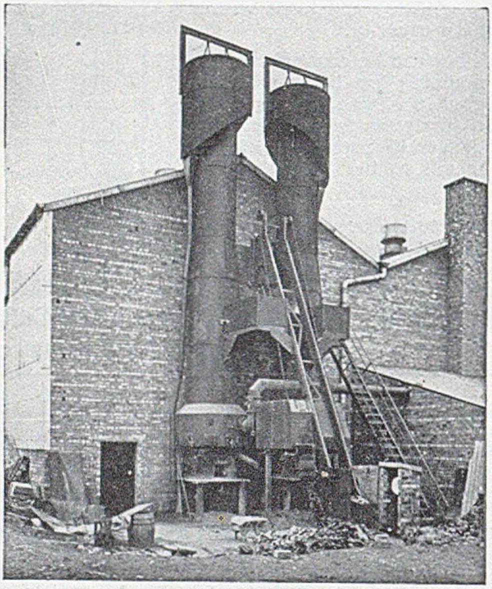

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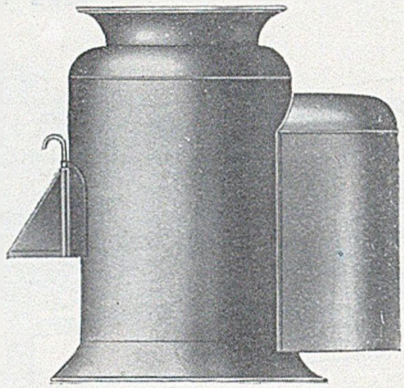

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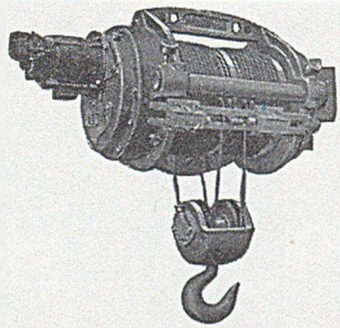

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