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PRINCIPAL CONTENTS

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Gaps

Whilst uppermost in people's minds at the moment is the "dollar gap," there are many other gaps that, if closed, might make for the better conduct of the foundry industry, and so indirectly of the country as a whole. The first gap which comes to mind is the non-existence of a master-patternmakers' association, and we were forcibly reminded of this when, after a Paper given to a French audience on foundry training facilities, the Author was asked whether such a body co-operated in educational affairs. The answer was that the committee which organises the City and Guilds examinations in foundry practice had only the benefit of a representative of the patternmakers' trade union. The non-existence of a master-patternmakers' organisation is almost incomprehensible in view of the widespread growth of employers' associations since the war.

A gap in the field of technology is the lack of a section or branch of the Institute of British Foundrymen in the Southampton area. Yet it was from this city that the first letter for publication suggesting the formation of a "British Foundrymen's Association" emanated. Actually, it was written by the late Mr. James Ellis, who was later to preside over the Institute. Such a development at Southampton has a much greater chance of success nowadays because by the use of the small car, three or four of these vehicles, well-filled with foundrymen from the outlying districts, could together with the local people, furnish a worth-while audience. This is a matter which is being enthusiastically taken up at our suggestion by Mr. L. G. Beresford, the London branch-president. Another "gap" of a similar nature is to be found in the Doncaster area and that this is to receive attention was announced last week.

The third sort of gap is a variable, and is to be found in every industrial organisation. It may be in mechanical equipment or personnel. An example of this sort of omission may be cited as the one-time complete lack of metallurgical control (since happily remedied) in one of Britain's otherwise most progressive foundries. In some concerns, the gap takes the form of the absence of a man charged with the duty of plant maintenance. Then, of course, there is the traditional gap of there being no person to ensure proper co-operation between designer, patternmaker and moulder. More business has been lost to the foundry from this source than any other factor. For instance, in the early days of welding, a works manager, fondling an ugly-looking welded assembly, told the foundry manager he had lost job number X13, as when made by the new process it would only cost 7s. 6d. instead of 15s. as a casting. The reply of the foundry manager was that, if the customer would accept such a simplified design as the one shown, the casting would be "five bob." Whilst this is ancient history, it is constantly repeating itself to-day. Where this gap has been closed—as is the case with some of the larger concerns—it has not only prevented the loss of orders, but has attracted entirely new business. We believe it would be profitable for the average foundry executive to examine his organisation and extend somebody's job so as to fill in obvious gaps. Thereby productivity would be improved.

Vitreous-enamelled Selector Valve for Aircraft*

The building of better parts for aircraft requires unusual manufacturing techniques. Ground and lapped porcelain enamel on a stainless-steel aircraft fuel selector valve recently solved a problem of positive dependability under highly-critical conditions. The valves must function under extremes of temperature and humidity. Serious atmospheric contamination such as concentrations of sand or dust and corrosive conditions such as the presence of sea-water spray and chemical effects of additives in aircraft fuel are encountered. Under such conditions the working parts of the valve must provide a wear-resistant, non-galling and corrosion-free surface.

Most individual characteristics can be obtained with various types of metals, but the choice of a metal which will deliver all of these characteristics in a degree sufficient to pass the service testing requirements is difficult.

Aircraft fuel-selector valves must be operated totally dry over several thousand cycles without galling or excessive wear. Most of the possible metal choices fail in the extended dry-operation test. A combination of corrosion-resisting metal finished in vitreous enamel provided the answer to this problem. The valve passed all requirements of the armed services.

Cast Valve Used

A plug-type fuel-selector valve perfected by Aero Supply Manufacturing Company, Inc., is first cast in stainless steel and machined to precise dimensions. The outer diameter of the plug, which is the wearing surface in contact with the valve seals, is then vitreous enamelled. Service records show all-metal valves require repair about every three months. A prototype valve of the enamel-protected design has been in service for over five years without maintenance.

Special Enamel

A new acid-resistant type of vitreous enamel was developed especially for the job. Application conditions must be controlled critically to assure a perfect product. The plug design presents an outer diameter which cannot be porcelain enamelled at the top and bottom. The rest of the exterior diameter is recessed to receive 0.015 to 0.020 in. of enamel.

Some surfaces must be absolutely free while other surfaces must be covered with porcelain enamel in a coating not to exceed a tolerance of 0.005-in. thickness. Strict control of the enamel formula and firing temperatures must be maintained to assure a fully-matured enamel at a firing temperature which will not cause warpage in the casting. A final grinding and lapping operation on the external diameter of the plug brings finished dimensions to within a tolerance of plus 0.001 in., minus 0.000 in. Such an operation, while uncommon, has been successful.

* Reprinted from *The Iron Age*.

Aluminium Data Sheets

We regret that when reviewing the Data Sheet " Guide to the Selection of Aluminium Casting Alloys," we misread the covering letter. The phrase " this renders obsolete the earlier ' Technical Data ' folder," was quite wrong, as the technical data folder contains a dozen or more different sheets, and it is only one—the " Guide to the Selection of Aluminium Casting Alloys "—which is rendered obsolete by the publication of the revised edition.

Conference Paper Author

Mr. C. W. Stewart

Mr. C. W. Stewart, the Author of the Paper " Manufacture of Propellers and Other Castings," which is printed on the facing page, served his apprenticeship with Arrol-Johnston, Limited, Paisley. After a few years' service in the R.F.C., and the R.A.F., in the 1914-18 war, he entered the foundry of Alley & Maclellan, Limited, Glasgow, eventually becoming assistant foundry manager. He then joined the Shotts Iron Company, Shotts, as foundry manager, returning subsequently to Alley & Maclellan to become foundry manager there. In 1947, he became works manager with Chas. W. Taylor & Son, Limited, South Shields, and it is of the activities in this foundry that he writes.

Book Review

Fachkunde für den Modellbau (Technology for the Patternshop) (2nd and enlarged edition) by Emil Kadlec. Published by Springer Verlag, 20, Reichpietschufer, Berlin, W.35. Price 3.60 DM. (Note.—First edition was called " The ABC of the Patternshop "—the 72nd volume of a series covering various phases of engineering operations and skills.)

As with previous publications of this character, the booklet under review is profusely illustrated with diagrams of a self-explanatory kind, making the portent obvious to the practical man without referring to the text. Although largely elementary, there are many useful hints worth studying by the journeyman patternmaker and foundryman as well as by the apprentice, and the publication of this booklet translated into our language would possibly be a useful measure.

One or two points of technique are undoubtedly open to contradiction, a particular example being that of the method of arranging a lifting eye into a direct fastened plate. This, in the reviewer's opinion, should be arranged so that the plate could not be pulled out of its fastenings. Generally, however, there is much to recommend in the practical nature of the contents.

B. L.

Index to Volume 90

Readers are advised that the Index to Volume 90 of the Foundry Trade Journal covering the period January 4 to June 28, 1951, has now been printed. Copies are available free of charge on writing to the Publishing Office, Foundry Trade Journal, 49 Wellington Street, London, W.C.2. Regular subscribers are invited to apply for inclusion in a special list to whom copies of the index are sent automatically as published.

Latest Foundry Statistics

The British Bureau of Non-ferrous Metal Statistics reports that the production of copper-base castings in July this year was 5,104 tons, bringing the total for the first seven months of this year to 36,404 tons, as against 26,608 during the corresponding period last year. The production of pure copper castings is of the order of 500 tons a month.

Manufacture of Propellers and Other Castings*

By C. W. Stewart

The object of this Paper is to show how an old-established north-east coast iron foundry which, in common with other heavy industries in this area, suffered badly from the pre-war depressions, has to make the best of very limited space

This particular plant, which is over 60 years old, was originally laid out for the manufacture of smaller types of castings than those now being undertaken. To meet the increase in weight and size of these castings, 35 tons being about the heaviest made so far, cranes of greater capacity had to be installed and secondary columns put up to support the heavier loading on the crane runway girders. The foundry consists of a small shop in which small green-sand and dry-sand castings are made, and two main bays, approximately 240 ft. long, the larger of which includes the cleaning shop, being 40 ft. wide with two 35-ton overhead electric cranes and the smaller being 30 ft. wide with two 12-ton cranes. In addition, each bay has a number of hand-operated jib cranes. As the nature of castings undertaken ranges from propellers to marine-engine castings—reciprocating, Diesel and turbine—practically all the latter are moulded in pits, with the result that space is at a premium. More often than not, top parts have to be turned over, laid on top of the pit and finished, then stood against the wall before the pattern can be withdrawn from the mould and the drag completed. The whole set-up calls for a high degree of organising ability on the part of the foremen and a considerable amount of planning ahead, especially in the correlating of moulding and coremaking, so that, for example, moulds are not completed in advance of cores or *vice versa*.

Manufacture of Propellers

Propellers have been a speciality of the firm for the past 55 years and are now made from 4 ft. up to 19 ft. 3 in. dia. with three, four, or five blades as required. The heaviest propeller so far made weighed 22½ tons. These are moulded in loam on plates which can be seen in Figs. 1, 2 and 3. On the underside of these plates are bolted four bearings carrying flanged wheels of the type usually fitted to mould and core bogies, running on rails which extend into the drying stoves. In the centre of the plate a "cross" is fitted in which the sweeping pin revolves. The initial stage consists of the moulder making up his "bed," strickling it level and sweeping up the "cup," *i.e.*, the bottom face of the boss and print for the centre core. Next the dummy boss is built and strickled to size.

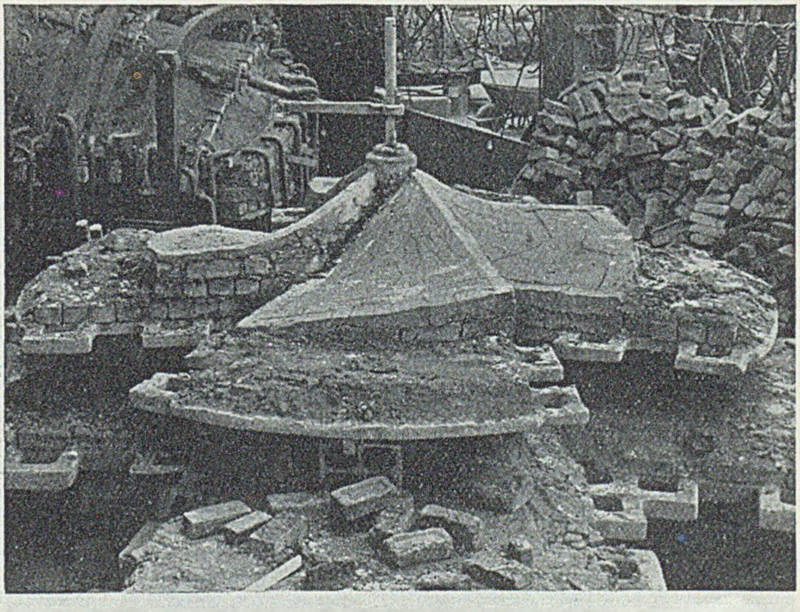


Fig. 1.—*Drag Part of a Loam Mould for a Small Propeller Casting.*

The patternmaker now marks off his datum lines and sets up on the first blade the pitch angles which have been made either in wood by the patternmaker or in steel by the blacksmith to the patternmaker's instructions. The moulder then fills in the drag around and up to these angles with loam and bricks and strickles the surface between them to form the working face of the blade plus the joints. The angles thereupon are withdrawn, the spaces they occupied filled in and the same procedure followed on the remaining blades. The plate is now drawn into the stove and given an overnight drying.

Building-up the Blades

Next morning the drag surfaces are dressed by

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

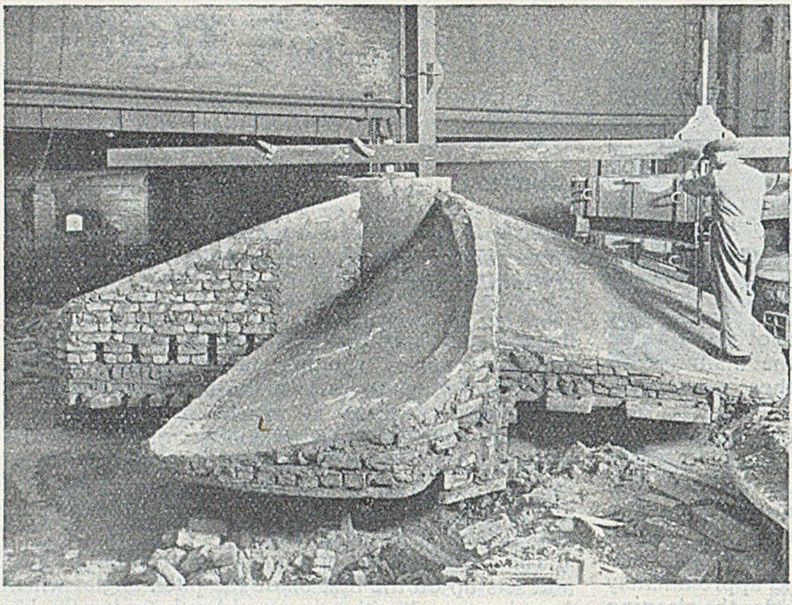


FIG. 2.—*Loam Drag Part for an 18-ton Propeller; the Craftsman is Checking the Pitch of a Blade.*

the moulder. The patternmaker marks off his pitch diameters on each blade, checks the accuracy of the pitches and sets up the thickness pieces which form the various blade sections. The moulder then rams up the spaces between these thickness pieces with floor sand and strickles the whole to form the pattern of the complete blade shape. These pieces are then withdrawn and the same operation is carried out on each of the other blades. The moulding of the copes is the next sequence. Side joint plates are bedded down on loam and cope or "bow" bars are fitted and securely wedged to the side joint plates to form a rigid unit.

From these cope bars are suspended "hangers" which carry the "slab bars." The surface of the blade is covered with loam to a depth of about 1½ in. and the slab bars, which extend from the outer edge of the cope right up to the boss, are slid through the hangers to rest thereon and the whole of the cope is filled up with loam and bricks. The partings of the cope are shaped to the necessary angles and the other copes then similarly completed. The top joint is now strickled level, covered with loam and the top plate bedded down, following which the mould is again dried overnight.

Finishing and Closing

On the third morning, the top plate and copes are lifted off, the sand thicknesses forming the blades are removed, the dummy boss is dismantled and the whole of the mould surfaces are dressed and finished, then "blacked." The mould is now given the third and final night's drying. On the fourth day, the copes are closed down, the centre core set, the top plate dropped on and the joints "loamed up" to prevent any "run-outs." The copes are clamped down (see Fig. 3), and binding bars are placed across the top plate and bolted to the bottom plate.

On the heavier propellers the outer edges of the bottom plate are wedged up from the floor to counteract any tendency to yield during casting. The runner basin and riser boxes are placed in position and the mould is then ready for casting. It will be appreciated that the temperature of the metal is very important as, if cast too hot, the danger of "strains" and "run-outs" is very considerable and, on the other hand, if cast at too low a temperature, there is the risk of "cold shuts" in the thin edges and trouble with dirty bores.

The times given above, *i.e.*, four days for the complete mould, apply only to propellers up to 9 tons in weight and 18-ft. 6-in. dia.

Gear-wheel Centre

Fig. 4 shows a 5-ton gear-wheel centre being cored up. The mould is strickled up in loam in the usual manner, the main cores are rammed in sand,

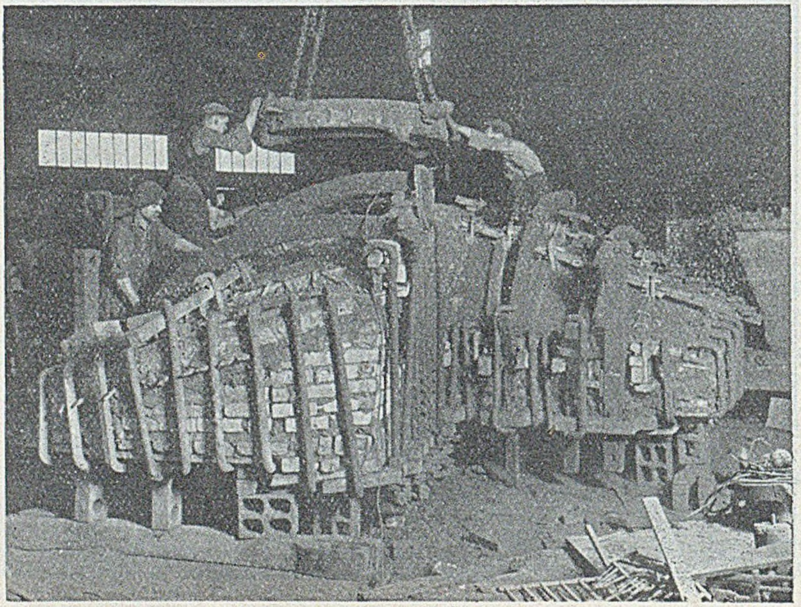
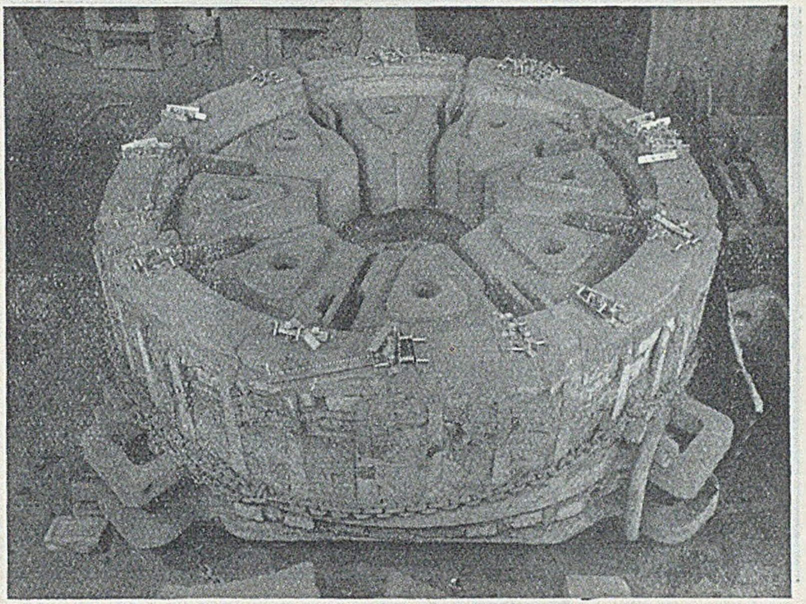


FIG. 3.—*Final Closing Operation on a 20-ton Propeller Mould. Note the Heavy Reinforcing Irons and Tie-bars.*

FIG. 4.—*Loam Mould for a 5-ton Gear-wheel Centre being Cored-up.*



the eight " cutter " cores in oil-sand and the centre core swept in loam. These smaller wheel castings are top gated on the rim and present no special problems.

Fig. 5 shows the initial stages of the moulding of a medium size gear-wheel centre, similar to that shown in Fig. 4, but in this case about 18 tons in weight. The method employed in this case may cause some diversity of opinion, but, again on account of the limited space factor, the method employed has been found to take up less room than would be required if the casting were made in the more orthodox manner, *i.e.*, sweeping the mould in loam with the usual bottom plate, cope rings, top plate, etc. When employing the latter method, a considerable amount of floor area is taken up with the tackle and this, in the case cited, just cannot be afforded. Therefore the job is treated more as a dry-sand mould and the cores left to the loam core-makers. The drag of the mould is strickled up in loam on the bottom plate and is dried in the stove.

It is thought that one of the most important points in the making of these castings is to ensure that the drag is thoroughly dried. Too often these wheel castings are to be seen with the top and bottom faces scabbed and " buckled " and, in most cases, this is due entirely to imperfect drying. After drying, the drag is allowed to cool off before being bedded down into the pit. In the pit, the bottom plate is rested at several points on box stools which have been built up from the actual bottom of the pit and is levelled up by packing from these stools. The whole of the remaining surface of the pit, which has been firmly rammed, is then covered with loam and the plate bedded down and levels re-checked. The dummy pattern is now strickled up, the top face being supported by the two half cast-iron plates, which can be seen in Fig. 5.

This dummy pattern is given a light drying to stiffen the loam, then the sand moulder takes over and rams up the mould in dry-sand. An ordinary top-part moulding box is used to cover the job and it has been found that it is cheaper to use this method, as the sweeping up of the dummy pattern costs less than the making of the necessary tackle for loam moulding. Also, the actual " closing " of the mould, using a pit with a top-part moulding box, simplifies the operation considerably as the ordinary binding bars are used across the top and bolted down to the pit. Both methods have been tried but there is no doubt that that now employed is the cheaper and safer.

Gating

The " gating " of these larger gear-wheel centres, which weigh up to 32 tons, is by two main down-gates on opposite sides of the casting, *i.e.*, four in all,

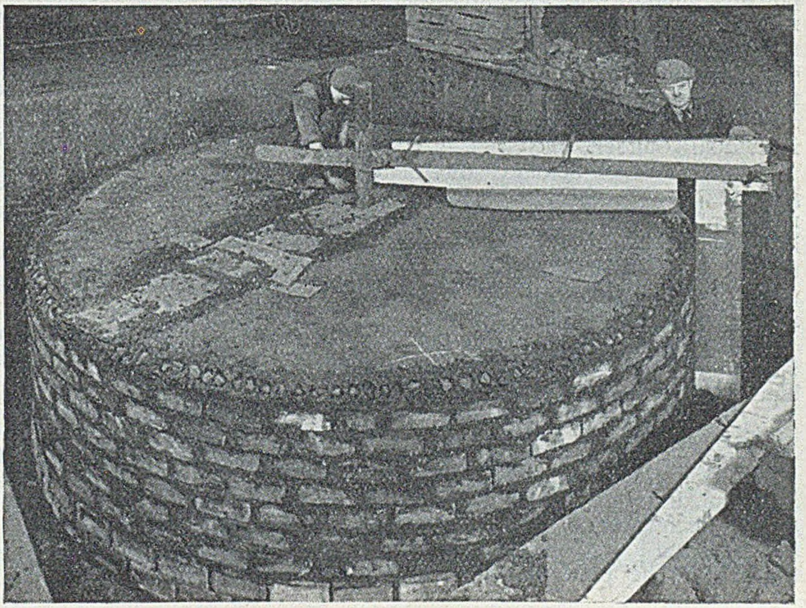


FIG. 5.—*Building the Dummy Pattern for an 18-ton Gear-wheel Centre; this Method takes up Less Floor Space than a Fully-strickled Mould.*

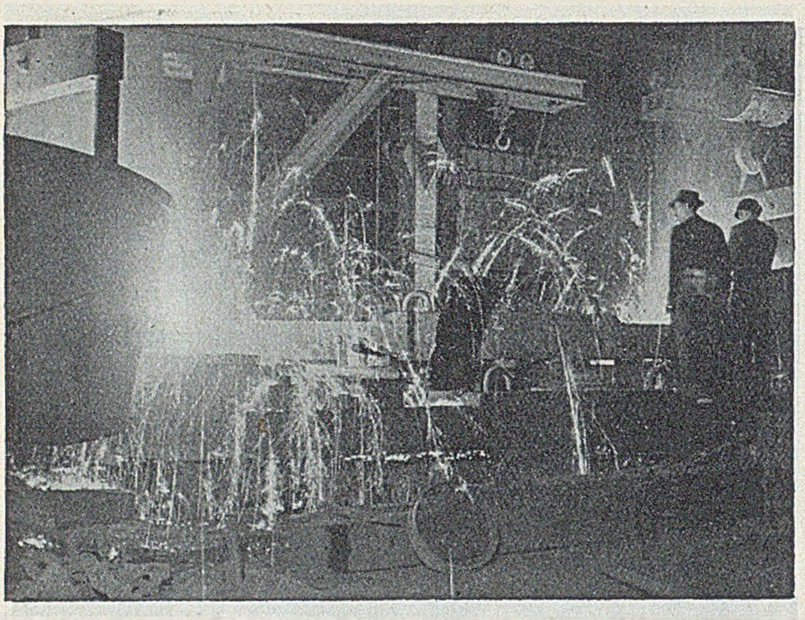


Fig. 6.—*Casting a 30-ton Gear-wheel, the Photograph was taken by a Junior Member of the Staff.*

each serving an ingate which is placed as low down on the mould as possible and opposite an internal rib. Four top-gates are provided on the rim and two on the top of the centre boss. Two risers are taken off the centre boss and six off the outer rim. The gates are covered with the usual conical type of plug and the practice in casting is to withdraw the plugs from the four main down-gates first in order to cover the bottom of the mould with a sufficient depth of metal, then two or more of the gates on the outer rim are brought into operation, the number actually used being determined by the speed at which the main gates are taking the metal and, lastly, the two centre gates are used to freshen up the metal in the bore.

On these gear-wheel castings the bore must be perfectly sound, close grained and free from any porosity, therefore it is essential that there must be no vestige of dampness in either mould or cores, that the whole mould must be thoroughly cleaned out and that a suitable grade of metal be selected for the job. The question of using chills in the centre core is a matter for the consideration of each individual founder.

Fig. 6 shows the actual casting of a 30-ton main gear wheel. The photograph was taken by a young member of the staff, Mr. James Askew, and it is included because it was considered to be one of the best "action" studies so far seen, giving as it does to the uninitiated a graphic picture of the pyrotechnic display accompanying casting.

Fig. 7 was taken immediately after casting a similar wheel and gives an appreciation of the binding-bar arrangements across the mould.

Medium-pressure Cylinders

Fig. 8 shows the drag portion of the mould of a 10-ton medium-pressure cylinder casting for a 48-in. stroke reciprocating engine. For these larger medium- and low-pressure cylinders, the usual practice is for the patternshop to supply the casting and receiver ends of the pattern only, the moulder strickling up a dummy boss for the cylinder barrel, to which the patternmaker fits the rest of the pattern. Some years ago, it was considered that these cylinders could only be made successfully in loam, but nowadays it is common practice to mould them in dry-sand with quite as good results as before. The actual making of these cylinder castings is generally always entrusted to a first-class tradesman as the nature of the work calls for a considerable amount of skill, in so far as the finishing of the mould is concerned, to give a good-looking casting. The numerous ribs and pockets, etc., require great care to ensure that no part of the mould is insecure, thereby tending to float during casting, and adequate provision for venting has to be provided.

Fig. 9 is a view of the top-part of the cylinder in course of finishing and gives an indication of the method of gating. The main downgates, one of which can be observed at the bottom of Fig. 8, are used to feed ingates into the bottom flange and these are brought into operation first in order to fill the bottom of the mould before using the top gates, seen in Fig. 9, which are distributed around the circumference of the cylinder barrel. The runner and runner basin are dried and plugs are used to cover all gates.

Varying Sections

One of the snags often encountered in these cylinder castings is the unequal thicknesses and masses of metal, especially where side walls join the barrel. In some cases, for instance, two walls are in close proximity and at an angle to one another. These often are not discerned until the mould is being cored up and it is difficult to anticipate all these points when castings are being supplied from various customers' patterns, as it is the exception rather than the rule for one set of cylinders to exactly duplicate those last supplied from a particular set of patterns. The remedy, of course, is to use chills on these heavy parts which can be seen on the preliminary examination of the pattern, and, in the case of those discovered during closing, the practice is to use spiral-spring denseners.

The necessity of making a well-finished casting has been mentioned, but the first and foremost aim is to supply a casting which will be clean and close-grained on all machined surfaces, especially in the bore, and that it shall pass the required hydraulic test. To satisfy these requirements it is a fundamental that the thorough drying of the moulds and cores, including all "stamps" or "seals" on joints

FIG. 7.—*Arrangement of Binding Bars on the Top of the Mould for the Gear-wheel Casting; Rod Feeding is in Progress.*

and cores, should be stressed again and again. In addition, it is imperative that all vents from cores should be sufficient in size to take off the large volume of gases which can be evolved from almost totally-enclosed cores. The temperature of the metal should be as high as possible so that the mould can be poured at a reasonable speed, thus giving the core vents and gases sufficient time to disperse through the appropriate channels.

Low- and High-pressure Cylinders

Fig. 10 shows a bottom half low-pressure turbine cylinder mould, an example of craftsmanship at its highest. This particular casting is moulded from a skeleton pattern and requires seven drawbacks to be made to enable the pattern to be withdrawn and to permit coring up. One of the troubles that affect the jobbing founder nowadays is the shortage of really skilled moulders to whom can be given such a job with the knowledge that they can be trusted to make a really creditable casting. The aftermath of the depressions is evident in the gap between the older, well-trained moulder and the young, comparatively inexperienced journeyman of to-day. In this connection, Fig. 11 illustrates a small high-pressure cylinder for a 27-in. stroke reciprocating engine, weighing about 2½ tons, in process of being "cleaned." These smaller cylinders are given to the younger journeyman in an endeavour to train them for advancement to the making of larger types, and the management has to prepare itself for disappointments if their hopes in this direction are not always fulfilled.

In Fig. 12 is shown a 24-ton gear-case base for a marine turbine being despatched. This type of casting is in many cases being superseded by a fabricated unit, but it is pleasing to note that some ship owners still favour the time-proved cast-iron casting. The Author has not been able to ascertain how the relative costs compare.

Conclusion

In conclusion, the Author would like to place on record a tribute to the craftsmen in his area who, under difficult conditions, which to the founder possessing modern buildings and facilities must appear archaic and chaotic, still manage to turn out castings which compare favourably both in appearance and cost with those made in more up-to-date establishments. It is a pleasure to record that, in the case of the Author's foundry at any rate, these craftsmen will not tolerate any hold-ups which might prevent their getting on with their work, and as a result the foremen have literally to be "on their toes" all the time to avoid any complaints reaching the management as to their worth.

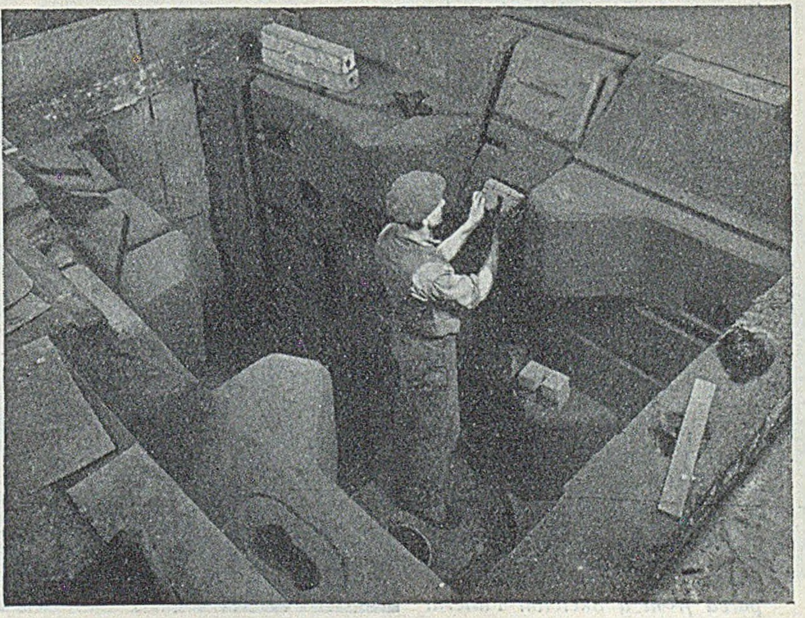


FIG. 8.—*Fitting Small Cores in the Drag Part of a Mould for a 10-ton Medium-pressure Cylinder for a 48-in. Stroke Reciprocating Engine.*

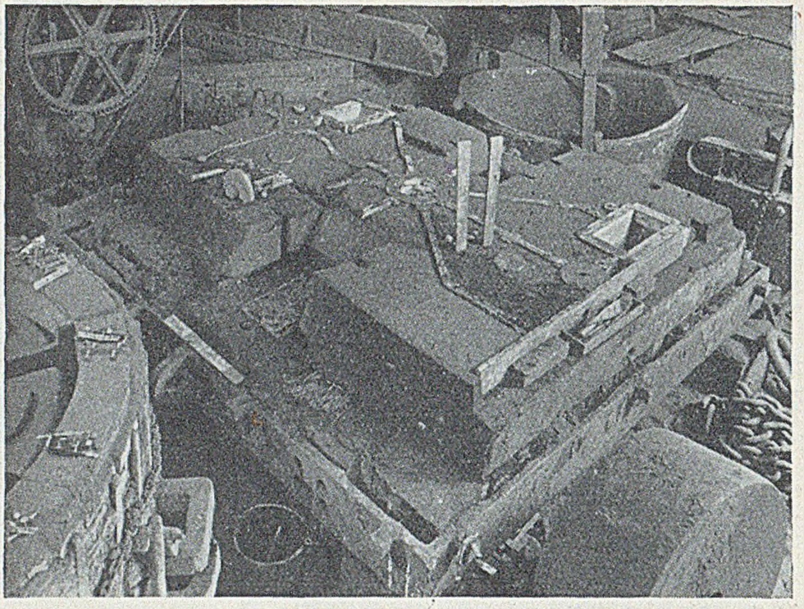


FIG. 9.—*Mould for the Medium-pressure Cylinder, with the Top-part Closed, Showing the Gating Arrangements; Runner Boxes have yet to be Placed in Position.*

An outstanding example of their "getting on with the job" occurred recently during an electricity cut in the late afternoon when all the lights went out. It gave one great pride to see these men working away in the darkness with candles, "duck" lamps, etc., when they might just as easily have sat down until the power was restored and then claimed waiting time. If all the people in the country worked half as well as the Tynesider there would not be the necessity for so many exhortations from our various Ministries for increased production. Practically all the moulders, coremakers and cleaners are on piecework and, with the exception of the usual differences of opinion regarding prices, disputes are rare, and relations between men and management very harmonious.

The Author is indebted to the Northern Press, Limited, South Shields, for their kind permission to reproduce the photographs in Figs. 7 and 10 and also to the directors of Charles W. Taylor & Son, Limited, for their permission to publish this Paper.

* * *

In his spoken introduction to the Paper at the Newcastle-upon-Tyne Conference Mr. Stewart apologised for the fact that the foundry concerned was rather old-fashioned and had no modern mechanisation to show or explain, but, he added, it was difficult to decide whether it was cheaper to employ labourers to handle sand than to employ a gang of skilled fitters to look after expensive machinery, conveyors, etc.

DISCUSSION

Opening the Paper for discussion, the CHAIRMAN (Mr. E. Longden) said the foundry about which they had been hearing was one of those which existed mainly on the skill of its craftsmen. Many shops were just mechanised moulding plant, but he suggested to Mr. Stewart that the excellent craftsmen which his firm employed made the making of moulds look very easy. Nevertheless, he thought much of such skilled work was commonplace in Mr. Stewart's foundry. The Paper had proved intensely interesting to many of them. He thought it a mistake to show a picture with the comment "This is a mould," and to gloss over the real skill and craftsmanship which had gone to the making of it, often under very adverse conditions.

Randupson Process

MR. G. R. DAY said Mr. Stewart had mentioned the difficulty of finding capital to pay for installations of new plant, but many were in that position. Quite frankly, he wondered if Mr. Stewart had studied the "Randupson" method of making propellors and, taking the long-term view, had realised the saving that could be made. The question of space did not enter into it always because the main

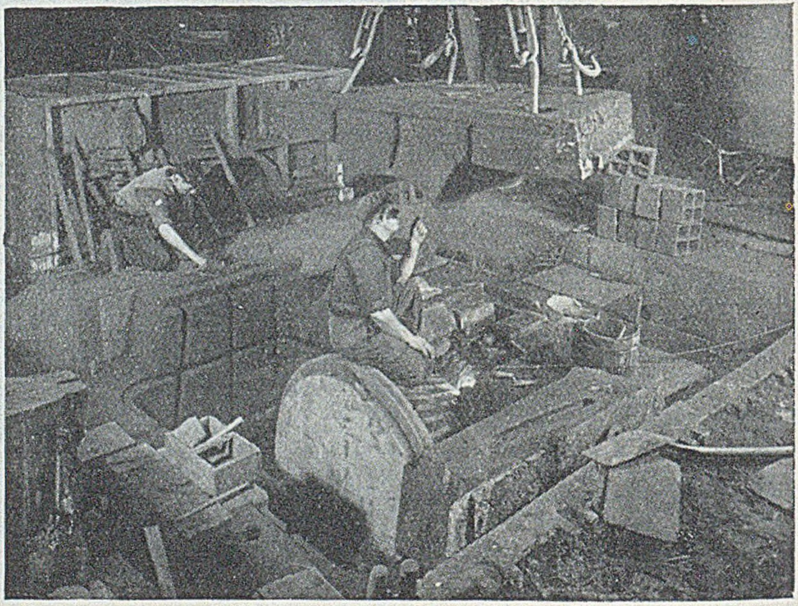


FIG. 10.—*Assembly and Finishing of a Bottom Half Low-pressure Turbine Cylinder Mould, prepared from a Skeleton Pattern.*

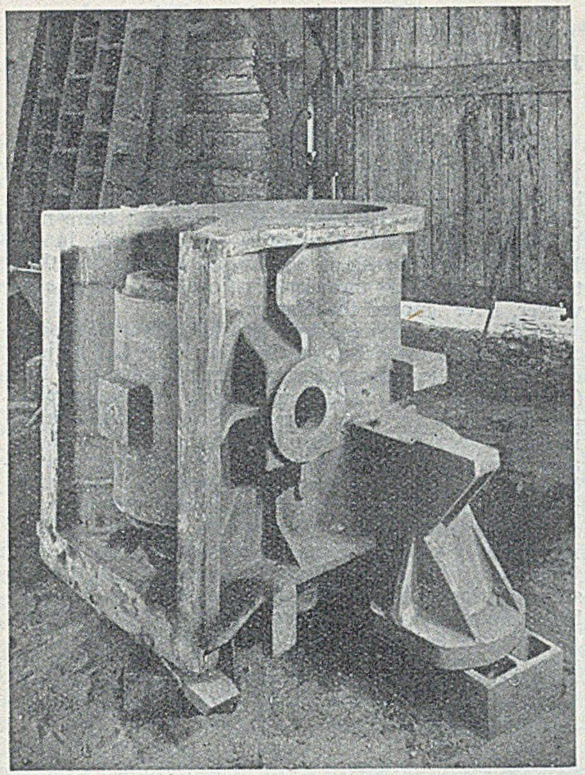


FIG. 11.—*Small High-pressure Cylinder Casting for a 27-in. Stroke Reciprocating Engine, after Cleaning. This type of Job is given to the Younger Journeyman Moulder.*

part of the equipment could be hung from the roof, but the time and fuel saved were stupendous, and he was sure the capital expenditure could be more than recovered in a very short space of time by using mechanised methods.

There was another aspect in that quite a number felt that propellor moulding was not a highly-skilled job in the sense that certain moulders found it difficult in trying their hands at something else after spending their whole lives on propellors. That was surely the test of skill; the skilled part of the job seemed to be in setting the template and building up the mould generally. He thought the operation could be broken down, thereby saving a worthwhile amount of money. It was his own experience that by that method it was possible to cut down the expense of moulding propellors by as much as 66 per cent., which was substantial, and also there had been introduced a certain amount of semi-skilled labour into the process. By that method, his firm always had skilled moulders always doing skilled work.

MR. STEWART said local conditions prevented the introduction of semi-skilled labour. Another point was that in his foundry a propellor was begun on Monday and cast on Thursday; by the mechanised process, how many days would it take? Could they do it in four days?

MR. DAY agreed it depended on the size and had to admit that, if Mr. Stewart could get that sort of production, he certainly had some men who really worked hard. Taking into consideration what they were doing, they certainly worked faster than bricklayers, he was sure.

MR. STEWART said in contrast that they had a bricklayer building a flue and the cost was counted per brick.

High Rate of Working

MR. R. D. LAWRIE said he was very glad to hear propellor making being spoken of. It was 35 yrs. since he had made his first propellor, and he had been interested in the times given. He was very pleased to see a time of four days for the making of a complete mould. Many people would say it could not be done, but it could, and was being done regularly. He would like Mr. Stewart to confirm that it could be done with four moulders and one labourer.

MR. STEWART said the times given were for but two moulders and two labourers. That was why he gave full marks to the people in that foundry; he did not believe it could be done until he came and found it was so.

A MEMBER said he was very sorry to hear the foundry criticised because 40 yrs. ago he had spent his most impressionable years in Taylor's, and they did very big jobs in those days. He had been impressed by the propellor making and he could

FIG. 12.—*Base Casting weighing 24 tons for a Turbine Gear Case of a Marine Engine.*

Manufacture of Propellors and Other Castings

confirm Mr. Lawrie's remarks that it was difficult to get people to believe that propellors could be produced in four days.

There was one point he would like to confirm, which he had not seen in any other place but Taylor's. In the matter of centre cores, did they still make them with a cover board and a top board, so that the core was in the vertical position, or had it given place to some other method?

MR. STEWART confirmed that the same process was still in use.

Present and Future Problems

Another MEMBER said they were faced with two problems: one was the shortage of skilled men and the other was the shortage of material to turn into skilled men. The only way they could find an answer to those two problems was surely to make available to skilled labour every possible aid that they could and, secondly, to try and make the foundry into a place which was attractive to young people. They wanted to get young people into the foundry to turn them into the skilled men who were so necessary for the production of heavy castings. He believed in mechanisation, for mechanised plant could, if wisely installed, be economic.

A MEMBER said it was a pleasure to find Mr. Stewart encouraging the young men to take over the intricate castings and he congratulated him on it.

MR. H. P. HUGHES said there was one point he would like to mention. Did Mr. Stewart envisage that conditions would remain as they were at present in his foundry? They had got to consider many wide implications. They were doing that work now, but what of the future? If they looked back they could see that that particular foundry had kept going because of its craftsmen, but what of the coming generations? Had they ensured their future by getting hold of the young men?

MR. STEWART said three and a half years ago he had gone to considerable trouble to produce a layout of an extension to the foundry with a modern bay and equipment. A model was made and shown to the directors of the concern. That was before he had seen Parson's foundry, but his scheme was on similar lines. He wanted to go ahead with the scheme; the directors were interested and an estimate was got out; at that time it would have been about a hundred thousand pounds for the prime essentials. Plans were prepared, but the day before the board met to consider it the Chancellor of the Exchequer put an embargo on any further capital expenditure. He had formulated a long-term policy and was hoping that they might get a new foundry some day.

A vote of thanks to the Author concluded the discussion.

IRON-ORE PRODUCTION in western Germany could be increased from 12,000,000 tons to 16,000,000 tons a year with relatively small investments, according to Dr. Monden, trustee of the Ruhrort-Meiderich steel plant, thus increasing steel output by 1,000,000 tons annually.

Publications Received

Journal of Research and Development, Vol. 4, No. 1. Issued by the British Cast Iron Research Association, Alvechurch, Birmingham. Annual subscription (six copies), £3.

For many years the publications of the British Cast Iron Research Association were confidential to members, and one subconsciously imagines this to be the case today. The significance of this is that there may be still some foundry executives who should, in the light of the new policy of the Association, see that their technical staff study these publications, but, like the reviewer, have ignored the change.

This particular issue is made up of Papers presented to a Conference on Malleable Cast Iron and the subjects covered include melting furnaces using pulverised fuel (air furnaces, Brackelsberg and Sesci) and oil, duplexing, pulverised fuel for annealing, and gaseous annealing, and annealing black-heart malleable in a controlled-atmosphere furnace. These together constitute a well-balanced statement of the existing state of the art of melting and annealing malleable with perhaps a glimpse of future developments. This particular bulletin could be improved by giving improved legibility to Fig. 1 of Mr. Perrott's Paper either through increasing its size or simplification. A novel feature admired, now it has been discovered, is the clear printing of the contents on the outside back cover. The Bulletins are available free of charge to members and there is good reason why every iron foundry in the country should be members. It is merely a case of filling up the inevitable form.

Mechanical Properties of Nickel Alloy Steels. Published by the Mond Nickel Company, Limited, Sunderland House, Curzon Street, London, W.1.

The steels under consideration are divided into two main groups, direct-hardening and case-hardening types. Specification details (chemical composition, heat-treatment and mechanical properties) are given for each steel, together with representative test-results which show the effect of mass. Tempering diagrams are included for the direct-hardening steels. To meet the present need to conserve alloying elements, there are some "economy" steels. Many of the standard steels described will again be available when the present situation has passed, so that the publication will provide useful information to those now dealing with designs in the early stage.

Among more general data are tables showing the effect of tempering and sub-zero treatment on case-hardness, torsion-test results, a graph showing the effect of surface condition on fatigue strength and a comparison of the various official tensile and impact test-pieces in use.

The data given and the method of presentation make this a very useful reference book for engineers, designers, metallurgists and heat-treatment superintendents. Copies are available to our readers, free of charge, from Sunderland House.

House Organ

Sif-Tips, Vol. 14, No. 74. Published by the Suffolk Iron Foundry (1920), Limited, Stowmarket.

Some of the welding jobs recorded in this magazine are really remarkable and done so quickly and cheaply that even if they only "tide over" the customer they are worthwhile. However, one has, in the absence of contrary evidence, to presume they last a lifetime. One case illustrated is a baling machine smashed into three pieces and repaired in four hours.

Dust in Foundry Operations

Written Discussion of Conference Papers

What follows are written contributions and Authors' replies to the considerations of the I.B.F., Newcastle-upon-Tyne Conference Papers :—" Reduction of Dust in Steelfoundry Operations " by W. A. Bloor, and " Observation and Control of Dust in Foundry Dressing Operations,"† by R. F. Ottignon and W. B. Lawrie, M.Sc. Among the points now arising are :—the interpretation of the data in relation to iron foundries; suggested modifications of the fettling bench; recommendation that the causes of dust should receive consideration by way of cleaner stripping; other methods of dust estimation and advice on dust photography.*

MR. W. D. BAMFORD, A.M.I.E.E., wrote that the Authors had read Papers which were of particular interest, and he wished to express appreciation for the work they had carried out and which he was sure had resulted in valuable information being placed at the disposal of foundry managements and the engineering profession.

The engineer specialising in design, utilisation and maintenance of plant embodying dust-control equipments had been handicapped by the lack of suitable methods whereby he could continuously determine both the direction and intensity of dust movements, and it was appreciated that the development of the visual method described by Mr. Lawrie had put a new tool into his hands. He looked forward to the development of an instrument of this type which may incorporate some comparative method for assessing the density of dust clouds on perhaps somewhat similar lines to the system used in light photometry.

The photomicrographic comparison scales presented in Mr. Bloor's Paper seemed to have been prepared on data obtained in steel foundries, and he would appreciate an opinion on whether the Author considered that the divergence in the size of dust particles was sufficiently comparable to justify the use of the scales in the estimating of samples taken from iron foundries. It was stated that the results of dust surveys were dependent on the amount of general atmospheric pollution. Was this condition due not so much from inside air being contaminated by outside air as, perhaps, by the rate of air changes in the building being lower than usual due to such atmospheric conditions, thus permitting a build-up of process dust?

Fettling Bench Details

As to the fettling bench, it was noted that the output of the fan under working conditions was 600 instead of 1,000 cub. ft. per min., which suggested that the fan was operating close to its stalling point, in which case neglected filters and other factors contributing to the falling-off in efficiency between overhauls would, if not stall the fan altogether, probably reduce the output of the fan still further by an amount greater than the increase in back pressure would justify.

It would be appreciated if Mr. Ottignon would state the blade diameter and speed of the fan he was using, together with f.i.d. and stalling point figures for both c.f.m. and s.w.g. A characteristic of the true aerofoil-bladed fan was that the air was delivered axially, unlike the mixed-flow propeller blade, and he wondered whether excessive pressure head was being lost due to the air blowing abruptly against the casing of the bench, as shown in Fig. 3. Maybe turning vanes could be fitted or, better still, the fan installed with the shaft in a vertical position so as to blow directly up the exhaust duct. According to Fig. 1 of the same Paper, the exhaust duct appeared to be restricted to an area less than that swept by the fan blade, which would probably account for a high pressure-loss. If this restriction could not be avoided then possibly a diverging piece could be fitted in order to reduce the discharge loss. It would be interesting if Mr. Ottignon would say why he decided to bleed off the 50 cub. ft. per min. for the air curtain from the main exhaust duct. It appeared that the exhaust duct had been greatly restricted to develop sufficient velocity head to bleed off the air curtain. He would like the Author's views regarding the introduction of compressed air or the employment of a small auxiliary centrifugal fan as an alternative, thereby eliminating the restriction in the exhaust duct which, along with the modifications mentioned above, might enable the fan to operate at a more satisfactory position on its characteristic curve and, at the same time, might allow a thicker filter to be used.

MR. OTTIGNON replying in relation to his section of the Paper wrote that Mr. Bamford's suggestions to obtain a lower pressure-loss in the exhaust system of the bench were appreciated, and would be followed up. The decision to bleed off the air-curtain from the exhaust stack rather than fit a separate motor and fan as suggested by Mr. Bamford, was taken because it was felt that this would reduce the initial cost of the bench and also provide lower maintenance costs, although the amount involved was obviously not very large for a single bench.

Although in the trials compressed air was used to provide a clear air-curtain for one set of tests, it was not regarded as a practicable measure for normal use. If the air were taken from the shop mains at 80 to 100 lb. per sq. in. pressure the power requirements would be about 10 h.p. per bench for the air-curtain alone, and the cost of providing compressor capacity would be very expensive for a duty of this type.

Replying to Mr. Bamford, MR. BLOOR wrote that there would appear to be no reason why the photomicrographic scales should not be used in assessing

* Published in the JOURNAL, July 12.
† Published July 26, August 2 and August 16. In the JOURNAL of August 16 verbal discussion of the two Papers was reported.

Dust in Foundry Operations

samples taken in iron foundries and, in fact, the scales had been so used by him in a few of these foundries.

With regard to the effect of general atmospheric pollution on the results of the dust surveys, he wished to emphasise that his method of dust estimation would inevitably include all resolvable particles in the foundry atmosphere from whatever source. If, in areas of high atmospheric pollution, the general ventilation of a building was restricted, then a build-up of process dust would take place unless the dust sources were efficiently controlled by local ventilation.

Cleaner Stripping Advocated

Mr. T. H. Weaver wrote that on this problem of dust it was very gratifying to learn of the co-operation of so many people towards alleviating a troublesome evil. It was a very sound approach in working out the best and the most economic policy to preserve the health and life of foundry workers suffering the discomforts caused by dust in foundry operations. He felt, however, that particular attention should be given to obtaining a much cleaner strip of the dried sand or silt from the casting when being knocked-out from the moulding box, in preparation for the dressing or fettling operation. If this could be achieved and a clean strip obtained leaving the minimum of sand upon the casting, what was left could probably be removed by a vacuum process. Despatch of the casting to the fettler with the minimum amount of sand adhering would be one important step accomplished. The building for the fettling shop of the future should certainly have a substantially grated floor with a vacuum extraction. The walls should be designed at an angle instead of being vertical, with glazed bricks and running, disinfected water, and with the minimum amount of flat ceiling. Such approaches would lead to many sound and important suggestions. Perhaps someone could commence work immediately upon a working scale model so as to deal with the control of dust and its entire elimination at the earliest possible stage.

Mr. Ottignon wrote that Mr. Weaver's comments on the desirability of getting the best possible strip were obviously sound as there was still a big variation in the quality of strip obtained in different foundries; control of sand practice and casting temperatures were paying good dividends when well done.

One British steel foundry was at present building a fettling shop with a grated floor for the storage of castings, with fettling being done in ventilated booths, rather on the lines shown by Dr. Dadswell in his sketches on the blackboard at the conference. While much will be learnt from this, new fettling shops were not built every day and most attention would have to be given to methods which could be fitted into the many foundries who would have to manage with existing buildings for many years to come.

More Information Wanted

Mr. H. J. Young wrote as one who had the shocking experience of having one of his best men, a skilled and experienced moulder, sentenced to spending the remainder of his life as a labourer in the open air; only then had the awfulness of silicosis been brought home to him. It made him want to know all there was to know about it, to ascertain from others and to rack his own brains as to what could be done to reduce if not to eliminate such tragedies.

It was not clear to him what caused one man to contract the disease and leave adjacent workers free. Could silicosis be contracted by inhaling one particle only if it fortuitously adhered to a vital spot in one's lung? Could a stranger walking through a foundry just happen to get it? Must one inhale a lot, or be a long time in a dust-laden atmosphere in order to contract the disease? Was it a fact that an atmosphere perfectly pure to all one's senses might contain invisible particles far more dangerous than those of an apparently 'dirty' air? Such questions might be those of a novice, but he (Mr. Young) believed he was not the only person comparatively uninformed about this matter. He had the idea that the foundry of the future would have its sand-plant-mixers, pug-mills, regenerators, de-silters, dust-extractors, conveyors, etc., etc.—likewise its knock-outs, its fettling, its furnace charging and weighing, its core-stoves, and so on, separated entirely from the foundry proper. Many years ago, in Germany he saw two iron foundries built according to somewhat similar notions; but in those days his mind was more on cleanliness, good-housekeeping and so on, which in the light of his present knowledge and experience had little more significance than had an individual with only the *visible* parts of him clean.

Spillage, leaks in elevating plant, dust-laden girders and such-like, seemed to him to incur the risk of the sand (that is, its finest particles), becoming dried during falling and so air-borne perhaps forever, unless inhaled. However, he was perhaps ill-informed and wanted guidance by some authority. He had the privelege of collaborating for a short while with Mr. W. B. Lawrie and it was valuable experience. The writer's thanks also were due to Mr. Bloor for his Paper.

In reply to Mr. Young, Mr. Bloor wrote that the length of exposure to silica dust required to produce silicosis appeared to depend mainly on the amount and size of the dust particles breathed, but there were other influencing factors including a personal one. In certain industries, death from dust disease or accompanying infections had taken place in 2 years or even less, but in these instances very heavy concentrations had been accompanied by unfavourable conditions of temperature, humidity, etc.

It was true that, under certain conditions of lighting, a visually clean air may contain a high concentration of dangerous particles. Only those particles below about 5 microns in diameter could penetrate to the ultimate lung tissue and it was particles of this size which were normally invisible.

Mr. R. G. Hanson (Molineux Foundry Equipment, Limited) wrote that anyone who had had to do with the study of unwanted airborne dust knew well enough how tedious a business the getting of data by numerous dust counts could prove. Mr. Lawrie was to be congratulated on two successes; on putting forward the idea of observing fine dust by illumination and on putting the idea into practice. Whilst able to agree with the Author's statement that, in the present state of dust-control technique, it was not necessary to observe the smallest possible dust size ranges, he felt that that should be the object of all researches directed towards the reduction of the amount of dust in workshop atmospheres.

What he liked best about Mr. Lawrie's effort was not its technical refinement, but the Author's publication of the work at its present stage and in its present form, with the practical certainty that others would be stimulated to give attention to the same subject. Whilst the Paper showed the pressing need of further study and research, one must not lose sight of the fact that an orthodox dust-extraction unit was better than no unit and the larger the unit the better. It might well be that axial dust-extraction for floor-stand grinders would prove better than tangential for fine particles, but further experiments were so far not very successful. Being commercially as well as technically interested in the subject of the Paper, he had been stimulated to make further study of the problem and thanked the Author for that stimulus.

Dust Sizes Observed

MR. LAWRIE wrote that he agreed it was ultimately desirable to obtain information as to the behaviour of the smallest particle size ranges in industrial atmospheres, and that no claims had been made in the Paper as to the size ranges observed. On the other hand, many thermal precipitator estimations had been made on the dust clouds produced by the processes photographed, with the very general result that 60 to 80 per cent. of the particles were less than one micron in diameter. The clouds photographed would be well within the respirable size range, and on other grounds it might be anticipated that the illumination technique used would make it possible to observe dust clouds in the particle size range less than one micron. The estimation of the size ranges visible in varying conditions of illumination was, in fact, receiving attention.

It was gratifying to know that Mr. Hanson had been conducting experiments on axial dust extraction from floor-stand grinders as opposed to the traditional tangential extraction, because this was precisely the kind of original thought that it was hoped to stimulate by publication of the Paper.

MR. H. H. WATSON (Pneumoconiosis Research Unit) wrote that he seemed to remember seeing some years ago an exhaust attachment fixed directly to a pneumatic chisel used by a stone-mason. Could such a method of "local" exhaust ventilation be applied to the pneumatic tools used to strip and fettle castings?

In a Paper just published in South Africa (D. G. Beadle, "An Investigation of the Performance and Limitations of the Konimeter," J. Chem. Met. & Min. Soc., S.A., 51, 265, March, 1951) there were given figures to illustrate how widely a konimeter count can depart from the corresponding result with the thermal precipitator. The range of ratios quoted was from 0.11 to 3.82, the actual ratio in any one instance depending largely on the size-distribution and state of aggregation of the dust. He suggested that care must be exercised when interpreting Owens' jet dust-counter results, because the effects noted with the konimeter would be likely to occur in the Owens instrument, but possibly not to the same degree. He asked Mr. Bloor whether he had made any direct comparison between the Owens counter and the thermal precipitator.

Mr. Beadle had also given, in the Paper referred to above, the results of a statistical analysis of several series of konimeter samples taken every 10 secs. for periods of 30 min. or longer. He concluded that under the variable dust conditions he was examining (Witwatersrand gold mines) it was necessary to take 15 konimeter samples to ensure that the average had a standard deviation not greater than 20 per cent. of the "true mean count" over a period of approximately half-an-hour. It would be interesting to know whether Mr. Bloor found variations of the same order.

Dangerous Sizes

The agreement between the estimates obtained visually and by counting was really very good. Could Mr. Bloor advise on the training required for such skill and whether he had found some observers consistently better than others? The saving in time and strain over the miscroscope counting method is clearly appreciable. It would appear that visual assessment in this way would give a subjective measure of the total projected area of the dust particles on the screen. Some authorities would say that the surface area concentration of the particles of respirable size was a better index of dust hazard than the particle count. If this were so, it should be valid only if there were no large particles in the sample. Could Mr. Bloor say something of the size-distribution of the dusts he had examined?

When assessing, with a high-power microscope, dust samples taken in an industrial area, where the level of external atmospheric pollution was high (as given by a number count), it was often difficult to decide whether or not to incinerate the records to eliminate such particles, which were usually considered relatively harmless. Mr. Bloor did not say whether he incinerated his Owens and thermal precipitator records. An alternative method of minimising the numerical effect of particles of normal atmospheric pollution was to count only particles larger than, say, 0.5 μ or even 1.0 μ diameter, for few of these extraneous particles would be larger than this size. In this respect it was known that the microscope itself arbitrarily cuts out particles smaller than 0.2 to 0.13 μ (depending on the microscope.

If it were assumed that a surface-area concentration was more likely to represent hazard than a particle-number concentration, then one would lose little of the total surface area in the cloud, even in the respirable fraction, by not assessing the smaller particles.

Dust in Foundry Operations

In reply to Mr. Watson, Mr. Bloor wrote that the application of local exhaust ventilation to pneumatic tools by means of a small hood and flexible duct attached to the tool itself had been tried on an experimental scale. There were many technical difficulties involved. To be effective the hood had to be of such a size and so near to the working edge of the tool that the latter and the area being fettled were partially obscured from the operator. In the case of castings with re-entrant angles and projections, effective fettling became impossible. There was no doubt that the type of exhausted fettling bench described by Mr. Ottignon was the best available solution for the control of the dust produced from small and medium castings. The ideal solution, of course, lay in the production of better castings free from "burnt-on" material.

With regard to direct comparisons between the Owens counter and the thermal precipitator, a number of results had been obtained during the early stages of the foundry survey. The samples had been taken in various shops of a particular foundry but not in the immediate vicinity of a dusty process. The thermal precipitator sampling periods varied from 3 to 10 min. and Owens samples were taken at the beginning, middle and towards the end of the period. The samples were evaluated by the accepted methods for each instrument using a 2-mm. oil-immersed objective and X18 eyepiece and all resolvable particles were counted. No size-distributions were attempted but the general appearance of the samples obtained by the different instruments were similar in this respect and the median size was obviously below one micron. The results of the counts were given in the accompanying Table.

Dust concentrations in the immediate vicinity of foundry operations varied considerably and with "snap" sampling instruments like the Owens, the "mean" count could only be obtained by taking numerous samples. In general, the survey samples relating to particular processes had been taken during periods of maximum activity and, as such, stress the "peak," rather than the average, concentration. The results of general-atmosphere samples taken at frequent intervals usually showed a rapid build-up to a fairly steady concentration during working hours, which was followed by an equally rapid fall in concentration during meal breaks.

Consistency in visual counting, as Mr. Watson knew, could only be obtained by much practice. It had been found, however, that reasonably good agreement could be attained between visual estimates by inexperienced observers and visual counts by experienced observers on condition that the visual estimate groups were at least as wide apart as those given in the Paper and that the size distributions were fairly constant. More than 90 per cent. of the survey samples had very similar size distributions and were of the following order:—50 to 70 per cent. less than 0.5μ; 80 to 95 per cent. less than 1μ.

Whether or not foundry dust samples should be incinerated was a subject on which there had been much discussion before the surveys were started. Although it was anticipated that some of the general atmospheric pollution particles not associated with the foundry would be included in the count, it was eventually decided not to incinerate on the grounds that

(1) One of the objects of the work had been to emphasise the fact that a general cleaning up of the foundry atmosphere was essential and that the cleaning up should include sources of smoke and fumes as well as siliceous dusts.

(2) From the point of view of future work it would have been extremely difficult to assess the efficiency of suppression methods for the siliceous dusts until the general pollution was greatly reduced.

(3) This general pollution mainly consisted of fumes from various sources and was not removed from dust samples by the usual incineration treatment.

TABLE I.—*Results of Comparative Tests of Thermal Precipitator Owens' Jet Apparatus.*
(Counts of all resolvable particles at 1,800 ×.)

Sample No.	T.P. particles per c.c.	Owens particles per c.c.			Ratio T.P./Average Owens
1	6,100	2870	2450	2570	2.3
2	5,900	2430	1910	1820	2.8
3	7,080	2070	1710	3380	3.2
4	11,530	3380	3740	3190	3.3(5)
5	5,480	1800	2630	1990	2.6
6	1,870	4960	4320	5630	3.8
7	19,100	4860	5410	6110	3.5

Illumination of Dust

MR. H. E. BELLCHAMBERS wrote:—In the interesting investigations which Mr. Lawrie has carried out, the high light-intensities required for his film studies have made visible the movements of clouds of very fine dust particles, and at his request we have examined the possibility of doing this using a simple equipment and a relatively low-power lamp.

The system we employed can perhaps be considered as similar to that obtained when a beam of sunlight passes through a small hole in a window blind into a darkened room of normally dusty atmosphere. With this condition, a luminous pencil of light is obtained and the brightness or luminance of this dust beam should be capable of being measured with normal photometric instruments. To get as bright a beam as possible we used a 250-w. high-pressure mercury-type ME/D box lamp having a source brightness of approximately 10,000 candles per sq. cm. For the experiments, a simple lens with a tube fitted with diaphragms was used to give a parallel beam approximately 2-in. dia. At the invitation of the company, we visited the K. & L. foundries with Mr. Lawrie. Trials were made on two machines, each with two grinding wheels. Both machines were fitted with extraction fans, but the first machine that was inspected had a more efficient extraction plant than the second.

The beam of light was directed across the face of the wheels in each case in a plane parallel to the axis of the machine, and it was raised and lowered so as to scan the area between the machine operator and the mouth of the extraction cowling. This enabled the direction of the air current near to the machine to be observed by noticing the direction of movement of the particles of dust, and was most easily observed when looking almost down the light beam towards its source. On the first machine examined, the light beam revealed that there were two main air currents, one towards the operator produced by the rotation of the wheel, the speed of the airflow depending upon the peripheral speed of the wheel. The second air current was in the opposite direction to the first and was produced by the extraction plant, being above that due to the wheel rotation and also below the work rest.

Dust-cloud Intensity by Brightness

Using an S.E.I. brightness meter, it was possible to measure the luminance of the light reflected by the dust particles when viewed at an angle of approximately 10 deg. to the beam axis and in a direction towards the source. The reading obtained at this machine just above the work was 1 ft. lambert.

The second machine examined revealed that the outward air-flow caused by the rotation of the wheel was very great compared with the air-flow due to the extraction plant. This resulted in very dense clouds of dust rising up towards the face of the operator. The luminance was measured in the same way as at the first machine and the value obtained in this case was 5 ft. lamberts.

Readings taken in the lighting laboratory under relatively dust-free conditions in nearly still air and using the same equipment gave readings of 0.06 ft. lambert. The spotlight without the tube and diaphragm was also used to examine dust movement generally around the working area of the machine. Air movement of the dust particles was clearly seen. The experimental work indicates that with such an equipment some interesting observations can be made of the phenomena of the movement of the fine dust particles shown up by Mr. Lawrie's investigations. It is possible to carry out also some quantitative measurements, but the interpretation of these requires some further investigation.

Mr. Lawrie said that he was glad of the opportunity of thanking Mr. Bellchambers for the co-operation he had offered in the later stages of this work, and for the contribution to this Paper in which he described what had been done and indicated some early results. This contribution by Mr. Bellchambers would show Mr. Bamford some of the developments that are being pursued in an effort to provide an instrument which might given rough indications of the density of the dust clouds observed.

Mr. Weaver had indicated quite the best, but quite the most difficult way of dealing with dust when he said that particular attention should have been given to obtaining a much cleaner strip so as to leave the minimum amount of sand on the casting. The complete elimination of dust was always better than the control of a dust cloud which had already been generated. This method, however, represented long-term policy, and was not discussed in the Paper because the Paper was concerned only with the control of dust by local exhaust ventilation. Mr. Weaver might be interested to know that the present Paper described one small part of the work on dust in foundries. The full scope of the efforts that were being made was indicated in the second report of the Dust in Steel Foundries Committee,[1] and this report served to draw together in a coherent whole the various aspects of the problem under investigation, with a general discussion of the relative merits of the different avenues of approach.

He knew of Mr. Young's very great interest in all that affected the welfare of the industry because he had the pleasure of working with him for a very short time. He regretted, therefore, that limitations of space prohibited anything like a comprehensive answer to all the questions raised, but hoped that the following general points would be of interest.

Dangerous Conditions

Silicosis occurred when large quantities of free silica dust (SiO_2), of particle size below 5 microns, had been inhaled over a long period. Small quantities of the active dust, in the dangerous size range, might be inhaled into the air tubes and be removed by the natural defence systems of the respiratory tract, but heavy intermittent surges of dust might be particularly dangerous because the lung defences could be overwhelmed and some of the dust left in the lungs. It might be, therefore, that a fluctuating dust cloud which gave heavy concentrations at its peak was more dangerous than a steady concentration which remained in excess of the minimum, but well below the maximum concentration shown by the fluctuating cloud. Finally, for many reasons, individuals varied in their susceptibility to the disease, which explained why one man contracted silicosis whilst another did not.

It would be seen from these considerations that silicosis can neither be contracted by inhaling one particle nor by a stranger walking through a foundry. Lung changes which could be detected by X-ray had been seen after two years' exposure to a dust cloud in certain industries, but the average time of exposure for silicosis was 10 years in a steel fettling shop. The hazard was determined by the number, size range and chemical composition of the particles constituting the cloud, so that the risk in different occupations in a foundry would vary according to the concentration and nature of the dust cloud generated by the process. In the same way, similar work done by different methods might give different risks. For instance, moulders might work 20 years or more before showing X-ray evidence of silicosis. On the other hand, the use, in the past, of silica flour as a parting powder made one kind of moulding particularly dangerous.

The dangerous size range was less than 5 microns. This meant that the dangerous particles were invisible in ordinary conditions, so that Mr. Young was quite correct in thinking that an atmosphere which looked clean might be very dangerous. It was true, of course, that a dust-producing process often produced dust with a wide particle size range distribution. This meant that there would be par-

Dust in Foundry Operations

ticles in the cloud big enough to be seen, and which would indicate the presence of a dust cloud. They were, however, not the dangerous particles, and only served to produce unpleasant conditions and to suggest that dangerous particles might be present. It remained true, however, that a dust cloud might consist of large particles, in which case it could be seen, and the atmosphere was unpleasant but comparatively safe; but on the other hand, a cloud could consist of small active particles when the atmosphere would look clean and yet constitute a major health risk.

Mr. Young was entirely correct in stressing the need for good housekeeping, general cleanliness and the correct maintenance of dust retaining equipment, because the concentration of the airborne dust cloud was always raised by working in a dusty shop. In the present state of knowledge he was also right in proposing the segregation of dusty processes, because this limited the number of men exposed to the dust. This segregation could be done in time or in space. For instance, processes like stripping heavy castings might be done at night which segregated them from the bulk of the men employed in the foundry during the day. Alternatively, the dusty work could be done in a separate room giving physical segregation in space. Neither method, however, afforded protection to the men employed in the process, and, whilst they were always worthwhile, the main problem was still to devise suitable means of dust suppression or control which would protect everyone in the foundry.

[1] H.M. Stationery Office, London.

Restrictions Eased on German Industry

A law removing many of the prohibitions and limitations on German industry "to facilitate German industrial progress and the modernisation of production" was published by the Allied High Commission at Bonn on August 30. The law confirms and gives details of relaxations contained in earlier agreements between the High Commission and the West German Government.

The principal relaxations concern shipbuilding, steel production, chemicals and light metals, and optical instruments. West Germany now may buy, or construct within her authorised shipbuilding capacity, ships of any size and speed "except ships with military features." She may produce more than 11,100,000 tons of crude steel "where this will facilitate the common defence effort.

Mass Production Last Century

By T. R. Harris

The manufacture of large quantities of similar castings by mass-production methods is often considered to be an innovation of the twentieth century. While this is true so far as the automobile and electrical industries are concerned, yet there were in the last century a number of foundries which specialised in particular castings and could thus produce them cheaper than the general foundries, an example being the shops producing cast-iron railway chairs, so much in demand in the 'forties.

Another example of this tendency in the last century is recorded in some letters the writer recently examined written by an iron-master of Wales to an engineer of the West Country. The engineer possessed his own foundry and was engaged in producing pumping engines to drain the metalliferous mines of his neighbourhood. To raise the water to the surface large quantities of iron pipes—commonly called "pumps"—were required. (this being before the days of rolled steel pipe) and it was found to be cheaper to import them from Wales than make them locally as the West Country foundry was better adapted for engine work.

On January 12, 1836, George Crane wrote on behalf of the Yniscedwyn Iron Works to the engineer:—"The writer has been called away from home since our last by one of those calls upon his attention which so often occurs in the casting trade or he would have written to you before. We could undertake the necessary preparation for the execution of the whole of the pumps named in your favour of December 26 (for new models of several of the bodies, many new core bars, and an entire set of new flanches) for £47 5s. 0d. The expense will of course not arise to you again with your future orders many of which for castings of this description we flatter ourselves that you will find it to be to your interest to put into our hands when you have seen the quality of our castings, and become acquainted with the strength of our iron."

Apparently the engineer questioned the expense to be incurred for the equipment necessary for producing the castings for on January 20, Crane writes:—"We have postponed a reply to your favour of the 18th inst. to allow an oportunity of again looking over our estimate of the expense which must be involved in putting your order into hand, we regret to say that we fear that we can make no very material reduction in our charge.... We do not expect, we regret to say, from urgent previous engagements that we shall be able to ship a pipe in less than a month, we will do our best however for you."

A misunderstanding having arisen between the founder and the engineer because of the former's loose application of the phrase "several tons" led to the following letter of January 24: "To ironmasters who are daily turning-out large quantities of metal," writes Crane, "you from your experience as founders must be aware of the great importance to us of orders which will take a large quantity of iron for a single pattern without the incessant change of bores, patterns, core-bars etc., etc. in our moulding shop which orders for small weights of various articles require. For large pipes and retorts for the London trade it is no unusual thing to have orders for a hundred tons (or more) of a size. We have just completed an order one item of which was *400 retorts* of one size . . . Knowing the quantity of pumps occasionally at once required by new mines, we added, meaning that if a quantity of that description was ordered, that our price would be in such case 5s. per ton less but we never intended that limitation should extend to an order (however much we are obliged to you for it) of which the largest number *of one* size is 30 only . . . So many orders had in point of time precedence of yours that great delay in its execution has arisen than we could have wished. We are making very considerable extensions to enable us to turn out an increased quantity of drysand castings more rapidly than our present (tho' extensive) ways and means will admit. In 12 to 14 days you will be safe in sending a vessel for 30 to 40 tons more."

(*Concluded at foot of column one*)

Aluminium Casting Alloys

Newcastle Conference Discussions

At the Newcastle-upon-Tyne Conference of the Institute of British Foundrymen two Papers on aluminium casting alloys—" Casting Characteristics of Some Aluminium Alloys," by D. C. G. Lees and " D.T.D. 424—The Versatile Light Alloy," by A. P. Fenn—were given consecutively. What follow are reports of the discussions which took place on these Papers which to some extent are complementary.

Casting Characteristics of Some Aluminium Alloys

By D. C. G. Lees, M.A., A.I.M.

MR. D. C. G. LEES, in introducing his Paper (printed in the FOUNDRY TRADE JOURNAL, June 28, 1951), said that the work described in it had been carried out during the war in response to the varying needs of the moment. Its object thus varied from time to time, but in retrospect it could be seen that the information gained was likely to be of lasting value.

Originally, in 1940, research was being made into the production of a ductile aluminium casting alloy from available scrap. It had been recognised that supplies of virgin ingot for producing the aluminium/silicon alloy L.33 were likely to diminish and attention was devoted to the possibility of reducing the alloy content of available scrap so as to raise its ductility. It was further recognised that to be an acceptable substitute for L.33 any new alloy would have to possess good fluidity. Tests for fluidity or running power were already in existence, but none was considered to be completely satisfactory.

A special test-casting was therefore devised, and this made it possible to obtain reproducible test results. These showed that fluidity in the foundryman's sense is related mainly to metal temperature and varies comparatively little as between alloy and alloy. The eutectic aluminium/silicon alloy showed marked fluidity because its freezing point was so much lower than for the other alloys.

At the same time, tests were being made on the ability of certain proposed alloys to make simple castings containing changes of section. It became clear that some alloys with suitable mechanical properties would be troublesome in the foundry because of tendencies to give cracks or sinks and draws at places where thin sections gave place to thicker ones. That type of work helped to show the advantageous properties possessed by D.T.D.424.

Those initial results, and the need to avoid the use of unsuitable materials for high-grade aircraft castings, led to a systematic investigation being made on the casting properties of existing foundry alloys. In particular, aircraft designers required information on the loss of strength and ductility produced by porosity. The work on those subjects which was carried out in 1941-43 formed part of the basis of the Paper.

DISCUSSION

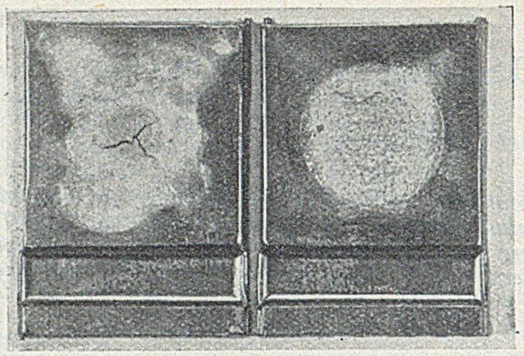
Gas Content

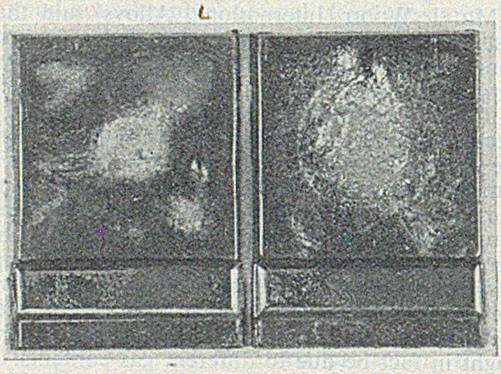
MR. J. WOOD (International Alloys) said that in tests in the laboratory, and also under production conditions, he also found that gas content had a very strong influence on the casting characteristics of aluminium alloys, confirming the results of Mr. Lees. Figs. A and B show test samples cast in the die developed by Dr. Scheuer, Mr. Williams, and himself, which illustrated the effect of gas content in reducing local shrinkage and hot-tearing. He had found cases where the difference in casting behaviour of two melts of apparently the same composition was due to gas content, and in many cases where the difference in casting behaviour was attributed to the presence of minor impurities, the difference might in fact be due to different gas contents.

MR. LEES, in reply, said it was a very useful point, and it had been practised in die foundries for many years to add gas as a means of overcoming shrinkage troubles. A few years previously he had contributed a Paper to the Journal of the Institute of Metals in which, using some of the tests for hot-tearing, it was possible to show a difference between certain alloys when gas-free and when quite gassy, and similar work had also been done at Birmingham University by some of the A.D.A. team of welding investigators. He had on one occasion made some very careful tests on two batches of D.T.D.424 alloy which were stated to have behaved very differently in the foundry. Quite considerable differences were noticeable in the test castings made experimentally, and he had found they could be accounted for completely in terms of gas content and grain size. He was not quite sure, after the lapse of time, whether he had managed to make the bad batch match the good ones by the simple modifications which the tests suggested, but it was certainly possible to do so.

Fluidity

MR. A. LOGAN expressed the opinion that the Paper was one which would repay further study, although if he were to be really critical, he would say that possibly some parts suffered from the disadvantage that the work described had been done ten years before and, when one read the Paper, that fact should be borne in mind. This was particularly so in regard to the question of shrinkage, and he thought a very useful thing would be to repeat the work which had been done on completely de-gassed material, and to repeat it with gassed





Figs. A and B.—*Samples of D.T.D.424 Alloy Cast in the "Shrinkage-test" Die, showing the Effect of Gas Content; (above) De-gassed, and (below) Gassed.*

material—gassed to definite degrees of gas content. That was information which the foundryman certainly needed very badly. They were apt to talk vaguely about metal being de-gassed or gassed, but they did not know the amount of gas which would cure the porosity troubles, from which die-casting founders in particular suffered.

One other feature he wished to inquire a little further into was the question of fluidity. Despite the conclusions arrived at in the Paper, fluidity was a very important factor from the founder's point of view; in fact, it might be of such importance that it dominated the choice of alloy completely. No practical founder needed to be told that the eutectic aluminium/silicon alloys had outstanding fluidity; it was an accepted fact and in certain die-castings, and even some sand castings, it might be necessary to use that alloy for that particular reason, simply because it might be the only alloy which would satisfactorily run a certain job. Probably everybody would agree with the statement quoted in the right-hand column of page 1 of the preprint: "Founder's fluidity must be sharply distinguished from fluidity regarded as the inverse of the true physical property, viscosity." On the other hand, he could not agree so well with the conclusions given, that, "as might be expected, temperature expressed as degrees of superheat is the main factor controlling founder's fluidity, and that the difference in this 'property' between the alloys tested is much less significant than the differences in other casting characteristics." In his opinion, the data published in Figs. 2 and 3 of the Paper did not warrant such a sweeping dismissal of fluidity. If they took the statement that the degree of superheat was the main factor controlling founder's fluidity and then referred to Fig. 3, if an arbitrary figure of 50 deg. superheat were taken for each alloy, they would get fluidity runs of 21½ cm. for commercial aluminium, 17 cm. for aluminium-silicon alloy (LM6), 14½ cm. for the 2 per cent. silicon alloy, 13 cm. for the 5 per cent. silicon alloy, and, lastly, 12 cm. for 4L11 alloy. That indicated that LM-6 was vastly superior to, say, 4L11 with the same degree of superheat. Founders, however, did not normally think in terms of degrees of superheat; they worked to a casting temperature which, by experience and use, had been shown to be suitable and satisfactory. In most aluminium foundries they found a very suitable casting temperature was round about 700 deg. C., almost irrespective of alloy, and if they referred to Fig. 2 and drew a vertical line at 700 deg. C., they would get (if it were permissible to extend the graph for LM-6) a fluidity run of approximately 28 cm. For aluminium of commercial purity they would get a fluidity run of 20 cm., for D.T.D.424 approximately 18 cm., for 4L11 approximately 14 cm.—again a very wide and significant difference, and a result with which he thought the aluminium founder would agree as being in line with his own experience of the relative fluidity of aluminium/silicon alloy and D.T.D.424. He would be very interested to have the Author's views on that, because he thought Mr. Lees had dismissed the question of fluidity far too lightly: it was a question of considerable importance and the founder had to pay some regard to it.

In his view, the test casting was very suitable for the fluidity test, and although he did not quite see the necessity for the very deep sump, probably Mr. Lees would be able to tell him the purpose of that. He would also like to know whether any tests were done without de-gassing, because that might affect the fluidity, not so much in the sand castings, possibly, as in die-casting. Fluidity was of particular interest to die-casters, and he would like to see a suitable form of test developed.

Difficulty with Intentional Additions

Mr. D. C. G. Lees agreed with Mr. Logan that a repetition of some of the work with gassy melts would be of very marked value to aluminium founders, and possibly it would be of interest to many other types of founders as well. Mr. Logan would appreciate that he was not in a position to do anything of the sort to-day, unfortunately. At the time when the work was done the interest had been much more on the properties which could be obtained in stressed castings for aircraft, and on the whole he did not think people put much gas into melts designed for such purposes. In fact, they were generally at some pains to get it out, and it was with that type of work in mind that the completely de-gassed melts had been used.

He had already mentioned some subsequent work which he had done and had reported on elsewhere, on the properties of castings made from melts gassed to an intentional degree, and he had found it most difficult to put in a controlled amount of gas. Nothing was easier than to put in a great deal of gas, and it was also quite easy, provided one had been taught how, to take it out, but it was extraordinarily difficult to put in a controlled amount. One put in a little and then tested, and found there was none at all, and then put a little more in and there was still none, and then one put a quantity in and discovered there was still not much present. There was undoubtedly room for a good deal of research and experimental work on the conditions for producing melts with a controlled gas content.

At the time it had not been possible to assess the gas content of melts in a very quantitative way. He had used the reduced-pressure test, in which one took a small sample and let it freeze under pressure of, say, an inch or so of mercury, thus expanding the voids to a size at which they were very easily seen by the naked eye. One could also see from the surface whether gas was coming out or not if one looked at the sample as it froze. More recently, of course, there had been great strides made in determining the gas content of samples by accurate vacuum methods, and he believed he was right in saying that there had been some collaboration between Dr. Ransley of the British Aluminium Company, using that type of apparatus, and practical foundrywork, and it was quite possible that they were getting somewhere with it.

Other Fuidity Factors

He had fully expected that somebody would think he had not devoted sufficient attention to fluidity, but he should point out that the work had been considered rather from the point of view of the sand foundry, where most of the larger castings were made, and he was not at all certain that in sand foundry work the property of fluidity was anything like as significant as it was in the die-foundry. He thought Mr. Logan particularly had in mind die-castings when he had referred to the importance of fluidity. He had no doubt at all that the aluminium/silicon alloys were very much more fluid at a particular casting temperature, and he thought it was quite permissible to say that the temperature in terms of superheat was not the only factor. When they had knocked that factor down to a common level, they did bring the alloys down to something more uniform than they were to begin with, and at the time when the work was carried out it was certainly clear that there were many other properties of the different alloys in which they were interested. Some of those alloys never saw the light of day; there were many far more significant differences between those materials than fluidity. Fluidity presumably could be corrected by a different pouring temperature, but a tendency to form severe tears in a simple disc casting so that one could easily see daylight through them was far more significant, and was one which was not so easy to compensate for by a change in a simple variable like a pouring temperature. It had been for that reason, and not because they thought they had got to the bottom of the subject and had finally dismissed it, that they had turned their attention to other properties.

Porosity Determination

Mr. Brace said the Paper was quite useful because it presented together under one heading information which previously had been rather scattered. Nevertheless he felt that some of the methods were open to a certain amount of criticism. In the first place, the methods used for determining susceptibility to porosity were a little surprising. He thought the work carried out by Ruddle and other investigators at the British Non-Ferrous Metals Research Association indicated that with bottom running, the temperature distribution in such castings showed that in general one tended to get colder at the top and hotter at the bottom, and therefore that fact explained why, with equal-size bulges, the bottom ones were rather more porous than the top ones. He believed it was true to say that, in general, aluminium founders rarely employed bottom pouring, and it would surely have been possible to have devised a test using the more normal methods of running rather than that employed in the series which they were considering. He thought his views were confirmed by the fact that, using a smaller bottom bulge, the porosity determinations showed that similar figures were obtained for top and bottom, because with a smaller bulge the amount of metal was less, the heat content was less, and therefore rather more uniform temperature distribution was obtained.

With regard to hot-tearing resistance, he felt rather doubtful whether Fig. 10 really justified the attempted interpretation that had been placed on it. The scattering of points, particularly in relation to the D.T.D. strength, was extremely wide; if one looked at values around the 80 per cent. mark and compared them with the eutectic index, there seemed to be variations between about 0.2 and 1.0, and those results were a little difficult to interpret in quite so simple a manner as a rather smooth curve. Some criticisms could also be made of the casting used to assess hot-tearing; the disc casting was rather unfortunately chosen because the method of running was such that, where the constriction existed below the riser, one would get a considerable heat concentration, due to the flow of metal past that particular point, and in fact one would tend to get a combination of both hot-tearing and normal shrinkage porosity, as indeed some of the results given in the table seemed to suggest. It seemed rather surprising that with LM-7 the hot-tearing resistance was high, but the pressure tightness extremely low, and from his own experience he was inclined to doubt very strongly the assessment made of the results on the LM-7. A factor which had to be taken into account was that combination of hot-tearing and shrinkage, plus a certain amount of scatter of results.

Pressure Tightness

Dealing with one or two small points, in the first place he wished to ask Mr. Lees if he could give

Aluminium Casting Alloys

any information as to the assessment made for LM-7 with regard to pressure tightness, and, secondly, referring to the effect of gas content, he felt that insufficient regard had been paid to factors other than that of the alloy composition. It had clearly been shown that there was a general relationship between types of alloys and the distribution of porosities, but in his opinion a further factor was the actual alloy composition. Work reported by German workers[1 2] and also recently two American workers[3] indicated that the alloying element present had some influence on the amount of gas that could be absorbed. For instance, the two American workers had reported that copper and silicon reduced the amount of gas which was absorbed by aluminium, and he believed there was some evidence to show that other metals increased it. He was, in fact, wondering whether, apart from the mere effect on the distribution of the porosity, it was not possible that the rather high amount of porosity present in the aluminium/magnesium alloys might not be due to the fact that they tended to absorb gas rather more readily than the alloys containing copper and silicon as their principal ingredients.

Effect of Magnesium

The Author remarked that criticism from colleagues was particularly welcome, because one knew that it was so kindly meant. Replying to the point about Fig. 10, he thought Mr. Brace had got his finger on something which might have been explained more clearly in the Paper. Some of the points where a rather low proportion of the fully-fed test-bar strength was shown for a given constitution could probably be explained in terms of a factor to which Mr. Brace had himself drawn attention, and that was the presence of magnesium, which at any rate in proportions of several per cent., led to an increase in the gas absorption. That was a matter which had been the subject of a great deal of study, and it was quite established that much gas could be absorbed during the solidification of the alloys unless very careful means were taken to prevent it. The means that were taken at the time were shown subsequently to be quite inadequate, and if more effective means had been known about and had been taken, he had no doubt some of the points, particularly the ones showing eutectic indices of about 0.35 and about 0.46 or so, would have been substantially raised.

Subsequent Knowledge

As regards some of the figures failing at lower eutectic contents, he wished to point out that subsequent work by Pumphrey and his colleagues of the A.D.A. Welding Research team at Birmingham University, studying the cracking of castings and welds made under conditions of restrained solidification, suggested that there was a region of low-eutectic content where susceptibility to tearing was at a maximum. That fact had not been appreciated when this work was carried out.

Mr. Brace had referred to various forms of test-casting used in assessing the effects of porosity, but nothing had been further from his thoughts when doing that work than the idea of producing castings which were made under ideal conditions of running. The idea had been to study the effect of porosity in a deliberate way, and therefore care had been taken to accentuate the defect to a considerable extent.

He could fully substantiate the remarks which Mr. Brace had made about the temperatures in bottom-run castings, as at the same time as that work was being done he had been assisting Mr. W. A. Baker on work in connection with the casting of magnesium-base alloys; the question of temperature gradients in castings of a similar form was studied and it was clear that, with the form of bottom running employed, the distribution of the porosity could be very greatly affected by changes in the size of the bulges, by their existence or non-existence, and also by the heat content of the alloy itself, *i.e.*, in terms of the pouring temperature for a particular melt, and also in terms of the specific heat and latent heat in different basis metals. The object of those various castings, he stressed, was to accentuate the defects as far as possible. The same applied to the pressure-tightness discs, although it might be that there had been rather too much accentuation there, so that some of the alloys which were intrinsically highly suitable for the making of pressure-tight castings then showed up to be somewhat worse than they really were, and LM-7 (R.R.50) was an example of that. There was no doubt at all from the many tens of thousands of tons of that alloy poured that it could be made into castings which would pass very stringent pressure-tightness tests.

Compositional Influences

Mr. Brace had further referred to the possibility that the composition of an alloy, quite apart from its constitution in terms of freezing range, and so on, *i.e.*, the different metals present, could significantly influence its behaviour in making castings. He had particularly stressed the possibility that the alloying elements might affect the amount of gas taken up, and that was a matter which, in the case of the alloys containing magnesium, had been studied exclusively. The presence of magnesium promoted absorption of gas—it happened both in the foundry and in welding. Copper and silicon might decrease the solubility of hydrogen in aluminium, but much of the work reported up to the present on the subject of the effect of alloying elements had been of a very unsatisfactory character. Until the recent work on the solubility of gases in aluminium, some extraordinarily divergent figures had been published, and it had been made clear that the presence on the metal of absorbed moisture or of hydrated oxide films could release a very great quantity of gas, so that, particularly if the specimen were comparatively thin, the gas content could be out of all proportion to the true solubility. In more recent years, using Dr. Ransley's methods, much more reliable figures had been obtained for the gas content, and the time was coming, if it had not already come, when the attention of research workers using that type of method was being turned to the equilibrium solubility of hydrogen in alloys containing copper, silicon and other elements. They would have to await its publication,* and he himself did not know any of the results obtained so far, but it was satisfactory to know that it was going on.

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[1] Bauklon, W., and Redhall, M. *Metallwirtschaft*, 1942, 21, 683.
[2] Bauklon, W., and Oesterien, F. *Metallkunde*, 1938, 30, 386.
[3] Opie, W. R. and Grant, W. J. *Trans. A.I.M.E.*, 1950, 188, 1237-41.

D.T.D. 424—The Versatile Light Alloy†

By A. P. Fenn, A.M.I.Mech.E.

MR. A. P. FENN pointed out initially that the captions under Figs. 1 and 2 in the Preprint might be misleading. In the text, the purpose of the figures was clearly given but it might be taken that those were figures taken after natural ageing, which they were not. Actually every specimen was heated to a temperature of 150 deg. C. for a period of eight hours in every twenty-four and allowed to cool down, and the tests were carried out at the end of each week.

MR. GITTINGS, in thanking Mr. Fenn, said he had the pleasure of travelling up with him the previous day and Mr. Fenn had been telling him something of the very early history of the aluminium founding industry. Mr. Fenn's experience in that direction was unique and he could write what would amount to a historical paper, and perhaps one day they would be lucky enough to have that from him. Therefore, coming from Mr. Fenn, with his tremendous experience, they could take it that if he thought D.T.D. 424 was the "maid of all work" in the aluminium foundry then it must be so. It must also be quite a comfort to founders, seeing that there were so many aluminium alloys, to find that there was one material which they could choose to do most of their work.

In the Paper itself there was one point which he wished to take up with the Author. Mr. Fenn mentioned at the bottom of page 2 of the preprint some improvements which might be obtained in the material with heat-treatment and then went on to say that if the alloy was free from magnesium it was found to possess rather different properties. He asked Mr. Fenn whether he had conducted some tests on the heat-treatment of the alloy without magnesium and, if so, what his findings were in that respect, and also if he could indicate generally what was the effect of magnesium content on the heat-treatment characteristics.

MR. FENN thanked Mr. Gittings for his remarks with regard to what might be called ancient history in aluminium alloys.

He was very glad that Mr. Gittings had raised the other point as he had kept it out of his Paper deliberately because he felt it was not exactly right to bring it in when dealing with a specification alloy in which, in nearly every case, magnesium was present. A considerable amount of work had been done with regard to that alloy, as far as possible, magnesium-free, and they were at the present time using a considerable amount of that particular alloy made up from virgin material heat-treated—either solution heat-treated or the full heat-treatment being given—and the answer to Mr. Gitting's query was that the ultimate tensile strength was possibly slightly under the maximum that could be obtained with the alloy with magnesium present but the elongation was considerably up in every case. In one particular case, using about 0.07 magnesium, which was what he considered should be aimed at where a ductile material was wanted, the gravity die-cast specimens, solution heat-treated, gave about 15½ tons and 6 per cent. elongation, and the magnesium-free about 15 tons and 10 per cent. elongation. The same remarks roughly would apply to the sand casting figures. The increase in elongation was possibly about 50 per cent., with somewhere in the neighbourhood of one ton drop in about 14 tons in tensile.

Present-day Advantages

MR. LOGAN said that the Author had certainly shown them just how versatile D.T.D. 424 could be, and it must be agreed that it was a good general-purpose alloy and was useful for a great variety of castings and conditions. It was also a very highly complicated alloy, as most people nowadays realised. After it had been developed, during the war, it was distributed over the country to a large number of foundries which had to use it without any of the knowledge which was now available, and the early use of it was by no means plain sailing. That was, of course, largely due to the absence of the kind of knowledge which Mr. Fenn had given in his Paper. Founders had found this a very variable and difficult alloy to produce and they had obtained their experience of it the hard way, whereas anybody starting to use it now was in a very much more favourable position; they only had to read Mr. Fenn's Paper.

As regards physical properties, the 2 per cent. elongation had always been very difficult to achieve. It had been mentioned that a sand-cast test-bar as-cast showed only 2 per cent. elongation but that it could be increased to 3 per cent. by heat-treatment. That factor had become fairly generally known in the early days but it must be remembered that D.T.D. 424 was specified to be used in the as-cast condition and foundries were not supposed to be fiddling about heat-treating test-bars. He well remembered that an A.I.D. concession was made of ½ per cent. elongation, making the requirement 1½ per cent. elongation, but even then many founders found great difficulty in achieving it consistently. Not long afterwards the link between elongation and magnesium content had become fairly obvious, and attention was focused upon the

* Since the meeting, the Author's attention has been drawn to a Paper by W. R. Opie and N. J. Grant, *Trans. A.I.M.E.*, 1950, 188, 1237, describing some excellent work on the solubility of hydrogen in binary alloys of aluminium with copper (up to 50 per cent.) and silicon (up to 18 per cent.).

† Paper printed in the JOURNAL, July 26, 1951.

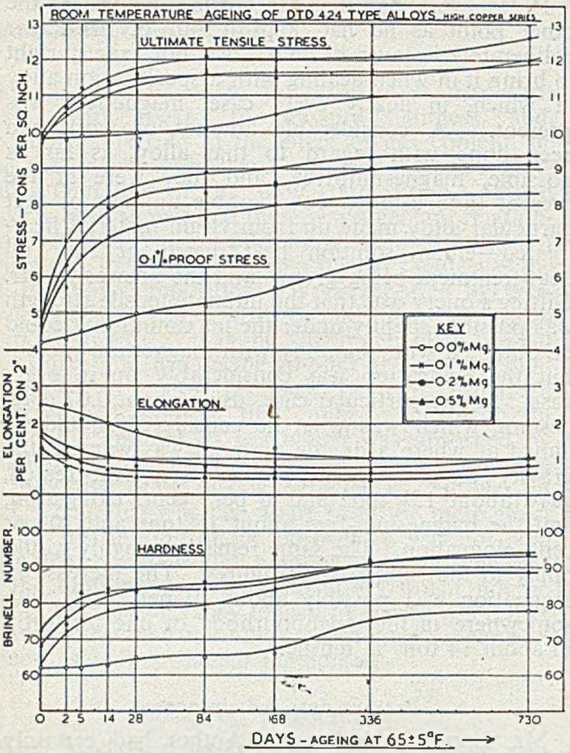

FIG. C.—*Ageing Test on D.T.D.424 Alloy, showing the Effect of Magnesium Content.*

amount of magnesium present. The permitted amount of 0.15 per cent. of magnesium seemed very small and the effect of it might be overlooked by those not conversant with aluminium alloys, but in fact, in conjunction with the copper and silicon present, varying small amounts of magnesium were quite sufficient to give a very wide variation of physical properties and to affect particularly the elongation. Magnesium also had a very marked effect on the dimensional stability of the alloy according to the amount present. A very valuable feature of the Paper was the figure indicating dimensional stability as obtained by various treatments, and Mr. Fenn deserved special thanks for putting these on record. It was extremely useful information from the point of view of those who had to produce castings with a high degree of dimensional stability.

Reduction of Magnesium Content

The question of magnesium content was really the vital factor in D.T.D. 424, and if high elongation was a desirable feature and was required then, of course, the ultimate necessity was to get rid of the magnesium, or most of it. One way to get rid of magnesium was to apply a flux treatment, and that could be and was applied to reduce very largely the magnesium content to a satisfactory level. As Mr. Fenn had rightly pointed out, where the material was free from magnesium it would be found to possess much superior elongation properties—usually well over 50 per cent. higher than the alloy which contained magnesium.

Another little feature which might be helpful and which had been tried and found useful in certain cases was to apply modification treatment, but whether it was worth doing depended on the purpose for which the casting was to be applied.

He had found the particulars of the large rotary vacuum filter casting very interesting, and it was certainly an achievement. He did not know whether it was claimed that it was, in the words of the popular song, "the biggest aspidistra in the world," but there seemed to have been quite a bit of competition recently for that particular honour.

MR. A. P. FENN, replying to Mr. Logan's first point about troubles in the foundry that were experienced in the early days, of D.T.D. 424 being thrust upon them on account of the fact that L-33 had more or less to lie into the background temporarily, suggested that it was not so troublesome to them really as they had imagined in so far as with D.T.D. 424 all the troubles came to the surface: that was one of the features of that alloy.

What he implied was that the founder had to scrap his own casting instead of the machinist scrapping it for him. The troubles usually came to the surface and were not buried in the inside of the casting, and that applied to many of the difficulties which were experienced on the change-over from L-33 to D.T.D. 424, particularly in the die-foundries where they were getting sinks on the outside of the casting; this fact he had an opportunity of proving to one or two founders in the early

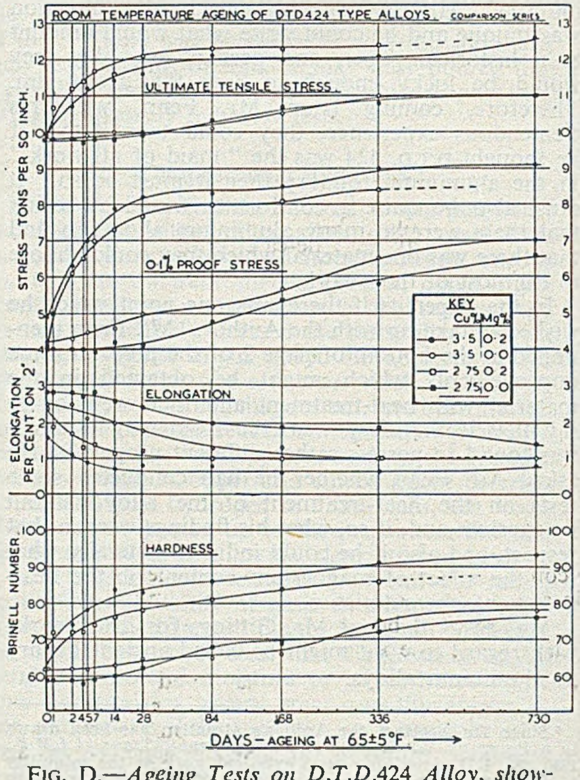

FIG. D.—*Ageing Tests on D.T.D.424 Alloy, showing the Effect of Copper and Magnesium Content.*

days of the war, when he had been more or less indirectly connected with the Casting Control. All the founders' troubles came into the Casting Controller, who had referred them to him, and he found that many of the troubles were "buried" in the particular casting when it was made in L-33 but they came to the surface when it was cast in D.T.D. 424.

Reference had been made to the question of the 2 per cent. elongation, but unless the magnesium content was below 0.1 per cent. that 2 per cent. was found to be exceedingly difficult to obtain. It had been obtained with over 0.1 per cent. magnesium, but it was with a little of the foundryman's art that he got it there.

Referring to the point which had been raised about flux treatment, he had not so far found any flux treatment which would completely remove magnesium. It would certainly bring it down to a very small amount, and he could assure them that the metal refiners, who had done such a wonderful job during and since the war in giving them good metal, would have fetched the magnesium right down to rock bottom if there was any flux treatment which would have done so.

Modification

A modification of the alloy was to a certain extent valuable in some sand castings but his own experience was that it had no advantage in die-casting, even to those castings which were made immediately afterwards and, of course, the melt had to be stored in holding pots during the die-casting and the effect of it soon went off, but it was rather amazing after the tests that they had made to find that it seemed to have no effect at all on gravity die-casting.

Speaking of the percentage of magnesium had brought back to his mind a problem encountered some years before in high copper alloy which was used for the production of die-cast pistons, and the composition had included magnesium to, he thought, 0.1 to 0.3. It had to be controlled accurately between 0.2 and 0.23 if they were not going to get troubles with cracking in the foundry in those particular piston castings, which showed the effect which even a very small amount of magnesium could have on light-alloy castings.

MR. CLARY said that as one connected with the usage of D.T.D. 424 he could say that the machinability was very much affected by magnesium. Could it be said that the aluminium founder was able to, and was prepared to, give the user an alloy containing a definite amount of magnesium, or within a controllable range, using 0.05 as minimum, and if so, could it be given as straight 424 alloy without any increase in price?

MR. FENN replied that Mr. Clary had touched on a point which was rather outside his particular sphere. In his view the aluminium founder was anxious to give to all his customers a material which, from month to month and year to year, was as near identical with regard to all its properties as possible, so that his difficulties in machining would not be found as he went along with the various batches of material that he got, but they must bear in mind that there was an economic point beyond which they could not go.

A further point was that the metal refiners were unable to offer a material which was absolutely "dead on" for its contents. In every specification a certain range was given, and that range was essential, otherwise it would not be given. If they could say that they could put 3 per cent. of copper, 5 per cent. of silicon, 0.5 per cent. of iron and 0.1 per cent. of magnesium into every batch of D.T.D. 424 that was ever made they would have reached their millennium. He was afraid that would never be, and the only way to achieve a greater degree of uniformity than was at present possible was to go over to virgin materials and make that alloy up from virgin materials, paying the extra price, and even then they would still get a certain amount of variation, although possibly not quite so much.

MR. TIPPER said that he had listened with real interest to Mr. Fenn. It was a very nice tribute from the Light Metal Founders' Association that he should give that Paper, and it was to be hoped that there would be more co-operation in future from the various sides of the foundry industry.

Service Properties

A point which the Author had not touched on in dealing with that versatile alloy was the question of application, or the service of the alloy, and he asked one question in connection with the large casting: was D.T.D. 424 selected with any regard to its service, *i.e.*, for the ammonia-scrubbing plants, and would the Author like to comment on the chemical or corrosion resistance or service properties of the alloy?

MR. FENN replied that the 424 alloy had been selected particularly for that large casting, about which a query had previously been raised as to whether it was the "largest aspidistra in the world." He had not claimed it as the largest but he had said that it was one of the largest and he was still waiting for someone to come along and say they had a bigger one, so from that they could take it that he believed it to be the largest light-alloy casting that had been made.

His firm had been approached by the actual user and the contractor who was going to construct the plant had been constructing it in cast iron and they wanted, if possible, a better life than they were getting. The recommendation had been made that the light alloy would give possibly greater life. Tests were made and the user approved the alloy after having had specimens in various points of circulation of the fluids, and it was then that it was decided to put two plants in hand, so it was actually a question of the resistance to corrosion of that material under those particular conditions that led to the alloy being recommended in the first place. It was not because they thought they could make the best casting in

Aluminium Casting Alloys

that particular alloy but rather that it would stand up to the work and so far the reports were that what they had anticipated was apparently coming along, and it was expected that they would get about five times the life that cast iron would give.

Written Contribution

MR. WOOD wrote that he had read with great interest the Paper by Mr. Fenn dealing with D.T.D. 424 alloy, and was particularly interested in the curves shown in Fig. 1, page 3, which illustrated the effect of ageing at room temperature on as-cast D.T.D. 424 alloy. In the laboratory at International Alloys, Limited, similar tests had been carried out over a period of two years using D.T.D. 424 type alloy with different magnesium and copper contents. The results obtained in these tests were shown in the two illustrations reproduced; all results were obtained on D.T.D. sand-cast test-bars, and each point was the average of one test-bar from each of three separate melts. Fig. C showed the effect of magnesium content on the ageing characteristics of an alloy with 3.5 per cent. copper and about 5 per cent. silicon. There was an increase in proof stress, ultimate tensile stress and Brinell hardness, and a reduction in elongation for magnesium-free as well as magnesium-containing alloys. The magnesium contents in two cases were of course above the specified limit for D.T.D. 424, but 0.2 per cent. magnesium is within the limit for ALAR 305 alloy.

The second illustration, Fig. D, showed the effect of copper and magnesium in this alloy. Test-bars had been cast from alloy melts of two different copper contents each with two magnesium contents. These curves showed the same general trend as in the previous graph, the melts with higher copper content showing higher strength and hardness. In all cases, the curves had been drawn through the points, and at the moment no explanation could be offered for the change in gradient in the curves in the range 168 to 336 days ageing. He did not believe that this gradient change could be due to changes in atmospheric temperature as this range corresponded to the period December to May. This could of course only be confirmed by repeating the tests, but this was not practicable at the moment.

In reply, MR. FENN wrote that he had been very interested in Mr. Wood's contribution, but in the first place wished to draw his attention to the fact that the curves shown in Fig. 1 on page 3 of the preprint did not illustrate the effect of ageing at room temperature but on test pieces which had been subject to continual heating and cooling up to 150 deg. C. during the course of the test, as was made clear in the text.

He was interested in the two graphs which Mr. Wood put forward, although these were not on materials entirely within the D.T.D. 424 specification. These graphs illustrated that with this type of alloy in the as-cast condition, a certain amount of age-hardening at room temperature did take place irrespective of the magnesium content. It further showed that the magnesium content increased this hardening, and Mr. Fenn suggested that if, at some time in the future, Mr. Wood was able to repeat these tests, that he should also include in the test specimens which had been subject to the stabilising treatment which had been suggested in the Paper.

With regard to the change in gradient in the curves between the range of 168 and 336 days' ageing, it appeared to him that the apparent upward tendency was due to the change in scale which had been made in the base line of the graph, the distance between the two vertical lines showing 168 and 336 days being much less in proportion than between the two previous points. Mr. Fenn thought that if Mr. Wood checked his graph on a large scale, he would find that the upward trend was non-existent, and that from 28 days to 336 days the points would come almost in a straight line.

Changes in Steel Companies' Boards

The Iron and Steel Corporation has announced changes in the constitution of the board of Darwen & Mostyn Iron Company, Limited, Mostyn (Flintshire), which consisted of the chairman, Mr. Reith Gray, and four part-time and two full-time directors. A statement issued by the corporation says that in order to create a better balanced board, the corporation consulted the chairman of the company and arranged that two part-time directors—Mr. R. H. Storey and Mr. R. A. Storey—would retire. Mr. R. H. Storey, who is 79, subsequently stated that he resigned because of his age.

At the request of the corporation, Col. D. S. Branson and Sir Allan Grant have retired from the board of the Park Gate Iron & Steel Company, Limited, Rotherham. The statement announcing this says that, after consultation and in agreement with the chairman of the company, it was arranged that two of the part-time directors should resign and that two of the younger executives, prominent in the service of the company and recommended by the chairman for promotion to the board—Mr. T. Fairlie, works superintendent, and Mr. J. Wadsworth, staff and labour superintendent—should become directors.

Appleby-Frodingham Extensions

The chief features of proposed extensions to the Scunthorpe works of the Appleby-Frodingham Steel Company (branch of the United Steel Companies, Limited) are two new blast furnaces and large crushing, sinter, and blowing plant. Details of the project were announced recently by Lieut-Cmdr. G. W. Wells, general manager of the company, who stated that the plans had been submitted to the Iron and Steel Corporation of Great Britain. He said that the proposed extensions would involve the expenditure of millions of pounds. The main object of the plan is to increase the iron-making capacity of the works to keep pace with its own steelmaking possibilities and to supply iron to the Steel, Peech & Tozer branch of the United Steel Companies.

Lieut.-Cmdr. Wells also announced that in view of the expenditure involved in the new programme it was not intended to undertake any further expenditure on the slag heap. Instead, this would be amalgamated with two other local slag concerns, Clugston-Cawood, Limited, and the Eccles Slag Company. A new company will be formed under the title of the Appleby Slag Company.

News in Brief

THE TELEPHONE NUMBER of High Duty Alloys, Limited, has been changed from Slough 21201 to Slough 23901.

THE NEXT INTERNATIONAL FOUNDRY CONGRESS is being organised by the American Foundrymen's Society and will be held in Atlantic City, New Jersey, from May 1 to 7, 1952.

MANUFACTURERS from some 20 countries representing about 45 branches of industry have rented space at this year's International Utrecht Fair, which is being held from September 11 to 20.

DEFENCE ORDERS valued at about £1,000,000 have been received by the Clayton Dewandre Company, Limited, motor and general engineers, manufacturers of vacuum brakes, etc., of Lincoln.

TWO CARGO LINERS of about 9,450 tons d.w. have been ordered by the Anchor Line, Limited, one from William Doxford & Sons, Limited, Sunderland, and the other from Lithgows, Limited, Port-Glasgow.

JOHN CROWN & SONS, LIMITED, Sunderland, has obtained orders for two 4,000-ton cargo ships for Rolf Wigand & Company, Bergen. The ships will have a speed of 12½ knots and will be delivered between 1953 and 1954.

PART of a $6,000,000 order for Canada obtained by C. A. Parsons & Company, Limited, Newcastle-upon-Tyne, an electric stator, weighing 125 tons, for the Ontario Hydro-Electric Commission, has been despatched.

CONSENT HAS BEEN GIVEN by the Capital Issues Committee to the Wellman Smith Owen Engineering Corporation, Limited, for an issue by way of capitalisation of reserves of 300,000 £1 ordinary shares on a one-for-one basis.

THE IMPORT DUTIES (EXEMPTIONS) (NO. 12) ORDER, which extends the exemption from duty under the Import Duties Act, 1932, to all forms of unwrought cobalt metal, which has been made by the Treasury, came into force on September 1.

AN EXTRA-ORDINARY GENERAL MEETING of Goodlass Wall & Lead Industries, Limited, is called for September 21 to capitalise £1,204,677 10s. from general reserve for a one-for-one scrip bonus. The issue is for shareholders registered on September 7.

AT A RECENT SESSION of the Trades Union Congress, Mr. J. H. Wigglesworth (Iron, Steel and Metal Dressers' Trade Society) drew attention to the dangers of pneumoconiosis in foundrywork and suggested the periodic medical examination of every man in the industry.

BRITISH RAILWAYS are to build a school for training apprentices at Crewe, Cheshire. It will be adjacent to the locomotive works and will become the "nursery" supplying the locomotive and other technical departments with some 270 apprentices each year.

THE CLAIM of the Confederation of Shipbuilding and Engineering Unions for a £1 wage increase for about 2,500,000 workers will be made at meetings with the Shipbuilding Employers' Federation on September 25 and the Engineering and Allied Employers' Federation on October 10.

JULY EXPORTS of textile machinery, worth £4,657,067, earned more foreign currency than ever before, exceeding the previous highest monthly total by more than £650,000. The volume of plant exported was 11,279 tons, the second highest monthly figure ever recorded, the peak being 11,640 tons in January, 1949.

AT BRADFORD CITY COURT, the Yorkshire Engineering & Welding Company (Bradford), Limited, was fined £50 and 10 gns. costs for having machinery not properly fenced. It was stated that as the result of an accident, alleged to be due to a faulty guard, an employee had had three fingers amputated and lost the tip of another.

AN ORDER for two 10,000-ton merchant ships for the Australian Shipping Ministry has been received by the Blyth Dry Docks & Shipbuilding Company, Limited. The ships, which will be completed in 2½ years, are being built in Britain on account of the labour shortage in Australia. The vessels will operate in the ore trade.

THE PROPOSED scrip bonus by Breedon & Cloud Hill Lime Works, Limited, is to be made to shareholders registered on September 10 on the basis of four new for every five held. The new shares will rank for final dividend payable for the year to January 31, 1952. Treasury permission has been granted, and a meeting is called for October 2.

CONCERN at the rising costs of the shipbuilding industry was expressed by Major Jackson Millar, chairman of the Fairfield Shipbuilding & Engineering Company, Limited, Govan, at the launch last week of the first of six ore-carrying vessels which the company is building for the Liberian Navigation Corporation. The recent increases in steel prices would put another £250,000 on the cost of the vessels, Major Millar told his audience.

MANY MILLIONS OF DOLLARS will be earned by the Furness Shipbuilding Company, Limited, Haverton Hill-on-Tees, which announces that it has received licences to build five 25,000-ton tankers—four for Canadian owners and one for a company registered in Panama. These vessels are not due for completion until 1957. During the past 12 months the company has booked orders for 20 ships with a total deadweight tonnage exceeding 400,000 tons.

STEELS ENGINEERING PRODUCTS LIMITED, of Crown Works, Sunderland have sent us details of the standard Coles electric hoist, together with a photograph of a foundry application—that of turning-over a rammed-up four-part moulding box. The range available covers loads for one to six tons using either a.c or d.c supply. Full safety arrangements have been incorporated in respect to power cuts, over-hoisting and over-lowering. The control is by push button.

BERALT TIN & WOLFRAM, LIMITED, announces that it has applied to the Treasury for a dispensation from dividend limitation in view of the obvious inequity of its incidence in the case of oversea mining companies generally and Beralt Tin & Wolfram in particular. Another statement will be issued as soon as further information is available. In the meantime, the directors regret that there must be some delay in publishing the accounts for the year to March 31 last.

ON SEPTEMBER 6, the British Engineers' Association elected as president for 1951-52, Mr. David D. Walker, M.A., M.I.E.E., joint managing director of Evershed & Vignoles, Limited, chairman and managing director of Thomas Walker & Son, Limited, and a director of J. B. Brooks & Company, Limited. As vice-president, Mr. H. S. D. Broom, M.B.E., B.SC., M.I.MECH.E., joint managing director of Broom & Wade, Limited, and a director of B.E.N. Patents, Limited, was chosen.

A VERDICT of "accidental death" was recorded at the adjourned inquest on Brian John Brotherhood (15), of Bradestone Road, Nuneaton, who died in the George Eliot Hospital, Nuneaton, from shock following burns received in an explosion at a light-alloy foundry in Nuneaton, on August 21. It was stated that there was a minor explosion during the drilling of some magnesium alloy, which was followed by a secondary explosion, and Brotherhood's clothing caught fire. Following the accident, the grinding shop has been reconstructed.

Personal

Mr. T. Brown, the deputy managing director, opened the Sheepbridge Engineering new sports ground, at Newbold, Chesterfield.

Dr. J. P. Dennison, a native of Bradford, who four years ago obtained his B.Sc. degree with first-class honours at the age of 20 and in 1949 was appointed assistant lecturer in metallurgy at Leeds University after obtaining the degree of Doctor of Philosophy for research in metallurgy, has been appointed lecturer in metallurgy at University College, Swansea.

Mr. R. Bell, for many years director and office manager of Smith & Wellstood, Limited, ironfounders, Bonnybridge, was honoured by the staff last week on his retirement from daily participation in the company's affairs. He received a silver cigarette box and a box of golf balls. Mr. Bell started his service in the Glasgow offices of the company, later being transferred to the London district. From there he joined the army, and soon after his return to Bonnybridge in 1919 was appointed office manager. He will remain a member of the Board.

Obituary

Mr. Benjamin P. Greenwood, a director of Vulcan Foundry, Limited, Newton-le-Willows (Lancs), died on September 1.

Financial director and secretary of the Chloride Electrical Storage Company, Limited, Mr. Cecil Murray Mills died on August 31.

A former director of Autovac Manufacturing Company, Limited, Stockport (Ches), Mr. George Arthur Gastall died on August 29. He was 84.

Mr. Richard Jones Davies, former commercial manager with Imperial Chemical Industries, Limited, at Grangemouth, died on Sunday, September 2.

Departmental manager of McKechnie Bros., Limited, metal manufacturers, of Birmingham, until he retired a few years ago, Mr. Joseph Latham Morewood died recently at the age of 70. He joined the company when he was 16 and served at Widnes, Manchester, and Newcastle-upon-Tyne before going to Birmingham in 1910.

The death occurred on August 28 of Prof. Gilbert Cook, Regius Professor of Civil Engineering and Mechanics at Glasgow University. Prof. Cook, who was 65, was well known for researches into a wide variety of engineering problems, and particularly for original investigations into the stress-strain relations of metals when passing from the elastic to the plastic state under systems of combined stresses. He was elected a fellow of the Royal Society in 1940.

The death occurred on August 29 of Sir Holberry Mensforth, former director of John Brown & Company, Limited, and its main associated companies, and a pioneer in the relations between workers and management. He was 80. A native of Bradford, he was apprenticed to a small firm of engineers in his home town and in 1904 joined the British Westinghouse Company (now Metropolitan-Vickers Electrical Company, Limited) at Trafford Park, Manchester, as a draughtsman, being appointed general manager of the works in 1917. He joined Bolckow, Vaughan & Company, Limited, in 1925 as managing director and, on the amalgamation with Dorman, Long & Company, Limited, in 1931, he became a director of that company. Later he was appointed chairman of the English Electric Company, Limited.

British Welding Research Association

The report of the Council of the British Welding Research Association for the year 1950/51, recently issued, recalls that the Association has now completed its fifth year, during which there has been a marked expansion in the facilities available to its members, and a record of good progress has been maintained. A small decrease in Ministry of Supply contracts is more than compensated by increased researches developing under the various committees, and work is also being carried out on behalf of the Admiralty in co-operation with the Imperial College of Science and Technology. The income for 1950/1 was £80,605, including £12,433 in respect of Ministry of Supply contracts and £6,388 contributed by members for the purchase of special equipment; the income for the previous year was £85,803. By prudent stewardship a surplus of £2,400 has been realised and transferred to the accumulated fund. The report expresses regret that the Association, in its endeavours to benefit industries interested in welding, has to depend so much on a quarter of its members who give more than the minimum subscription, and the Council urges each nominee to consider whether his company could not increase its contribution to accelerate the progress being made by the Association.

More Pay in July for 1½ Million

In the first seven months of this year, nearly 8,000,000 workers received wage increases amounting to £3,288,100. In the corresponding period of last year the number of workers affected was about 2,600,000, the total of the increases being £478,500, which was less than the increase in July, 1951, alone. Wage increases this year are running at over seven times the amount granted in 1950. The trend of the upsurge in weekly wages, month by month, this year is as follows:—January, £564,000; February, £551,000; March, £717,000; April, £360,000; May, £213,000; June, £314,000; July, £492,000.

In July, the upward trend, resumed in June, was continued and affected about 1,595,000 workpeople. Altogether this year about 7,921,500 workpeople have been granted higher wages, whereas in the first seven months of last year only 2,638,500 benefited. Workers in the iron and steel industry were among those to be affected by the principal increases last month.

Sir Arthur P. M. Fleming's New Post

The recent announcement that Sir Arthur P. M. Fleming had relinquished his executive duties as director of research and education with the Metropolitan-Vickers Electrical Company, Limited, while retaining his seat on the board, has been followed by the news that he has been appointed director of research and education of Associated Electrical Industries, Limited. For some years he has been chairman of the A.E.I. Research Committee, which co-ordinates the research activities of the manufacturing companies within the A.E.I. group and the long-term research of the A.E.I. laboratories at Aldermaston (Berks). In his new capacity he will undertake also the co-ordination of the educational work of the various companies. Sir Arthur is well qualified for his new work. He has a world-wide reputation as an authority in both these fields, and his frequent journeys abroad keep his knowledge continuously refreshed.

Increases of Capital

The following companies are among those which have recently announced details of capital increases:—

TENUOUS STEEL COMPANY, LIMITED, Sheffield, increased by £94,000, in 2s. ordinary shares, beyond the registered capital of £6,000.

ANDERSTON FOUNDRY COMPANY, LIMITED, Glasgow, increased by £45,000, in £1 shares, beyond the registered capital of £90,000.

OAKLAND METAL COMPANY, LIMITED, Willington, Derby, increased by £40,000, in £1 ordinary shares, beyond the registered capital of £10,000.

CRADLEY CHAIN & MANUFACTURING COMPANY, LIMITED, Cradley (Worcs), increased by £9,550, in £1 shares, beyond the registered capital of £450.

WOLF ELECTRIC TOOLS, LIMITED, Ealing, London, W.5, increased by £43,400, in 868,000 "B" shares of 1s. each, beyond the registered capital of £110,000.

S. RUSSELL & SONS, LIMITED, brass and iron founders, etc., of Leicester, increased by £50,000, in 5s. ordinary shares, beyond the registered capital of £300,000.

W. S. BARRON & SON, LIMITED, engineers, millstone builders, etc., of Gloucester, increased by £25,000, in £1 ordinary shares, beyond the registered capital of £65,000.

J. S. FORSTER & COMPANY, LIMITED, constructional engineers, etc., of Tipton (Staffs), increased by £40,000, in £1 ordinary shares, beyond the registered capital of £10,000.

ADCOCK & SHIPLEY, LIMITED, mechanical, gas, and general engineers, etc., of Leicester, increased by £35,000, in £1 ordinary shares, beyond the registered capital of £75,000.

JOSEPH STEPHENSON & COMPANY (LONDON), LIMITED, engineers' merchants, etc., increased by £45,000, in £1 ordinary shares, beyond the registered capital of £5,000.

BRITISH BRASS FITTINGS, LIMITED, Birmingham, increased by £26,748, in 660 ordinary shares of £1 each and 26,088 unclassified shares of £1 each, beyond the registered capital of £273,252.

HIRST IBBETSON & TAYLOR, LIMITED, ironfounders, mechanical engineers, etc., of Salford, increased by £50,000, in £1 5 per cent. cumulative preference shares, beyond the registered capital of £25,000.

T. & T. VICARS, LIMITED, manufacturers of biscuit-making machinery, etc., of Earlestown, Newton-le-Willows (Lancs), increased by £400,000, in £1 shares, beyond the registered capital of £100,000.

HUGH WOOD & COMPANY, LIMITED, colliery equipment manufacturers, etc., of Gateshead, increased by £180,000, in £1 5 per cent. redeemable cumulative preference shares, beyond the registered capital of £30,000.

DESOUTTER BROS. (HOLDINGS), LIMITED, manufacturers of pneumatic and electrical portable power tools, etc., of London, W.1, increased by £699,900, in 350,000 5½ per cent. cumulative preference shares of £1 and 1,399,600 ordinary shares of 5s. each, beyond the registered capital of £100. Converted into a "public" company on February 28, 1951.

Contracts Open

The dates given are the latest on which tenders will be accepted. The addresses are those from which forms of tender may be obtained. Details of tenders with the reference E.P.D or C.R.E. can be obtained from the Commercial Relations and Exports Department, Board of Trade, Thames House North, Millbank, London, S.W.1.

BOMBAY, November 7—Supply and erection of under-sluices. emergency gate, emergency rolling gates, etc., for the Bombay Municipality. Room 1118 (CRE (IB) 69489/51).

MALMESBURY, October 5—Provision and installation of hot-water heating supply systems, for the County Council. Mr. F. I. Bowden, county architect, County Hall, Trowbridge. (Deposit, £2 2s.)

PORT TALBOT, September 17—Supply and laying of sewers and surface water drains, etc., for the Gas Board. Mr. W. D. Rees, engineer, Port Talbot Undertaking.

ROMFORD, September 25—Provision and erection of Class B street lighting columns and lanterns, for the Borough Council. The Borough Engineer and Surveyor, Town Hall, Romford. (Deposit, £2 2s.)

Battelle International Institute

The Battelle Institute of Columbus, Ohio, is to establish a research centre in Europe. It operates on a non-profit-making basis and undertakes research for industry. The exact location is still undecided. It will also use European universities and technical colleges. Mr. John S. Croat is to be the executive director of this new Institute, to be known as the Battelle International Institute.

Joining Monsanto Board

At the recent meeting of the board of Monsanto Chemicals, Limited, Mr. Philip A. Singleton, who joined the organisation in 1940 as a member of the development department of the Merrimac Division of Monsanto Chemical Company, St. Louis, U.S.A., was appointed a director. In 1941 he became assistant to the general manager of that division and in 1945, as assistant to the president of the company, he became its chief representative in Washington. In 1949 he was appointed assistant director of the company's foreign department in St. Louis, and last year he joined Monsanto Chemicals, Limited, as assistant to the chairman and managing director.

A graduate from Yale Law School in 1941 and a member of the Connecticut and Federal bars, Mr. Singleton received a degree in engineering from the University of Michigan in 1935.

Industrial Museum for Birmingham

Birmingham is to have a permanent scientific and industrial museum. The city council recently acquired premises in Newhall Street from Elkington & Company, Limited, electroplate manufacturers, silversmiths, etc., and work is now in progress there to transform part of the establishment into a museum. The building contains 10 main halls and many rooms. Plans for the general layout of the museum are at an advanced stage. The museum will commemorate the engineering inventiveness and manufacturing achievements of Boulton, Watt, and Murdock, and will include a display of industrial plant from early times. Materials and models will be contributed by industrial undertakings throughout the country.

Pipeline Corrosion

The recording of corrosion failures of buried pipelines is the subject of a new standard form which has been prepared by a sub-committee of the British Iron and Steel Research Association, which is now responsible for the work on this subject formerly carried out by a Ministry of Health committee. B.I.S.R.A. hopes that the new form will be widely used to report new cases of corrosion.

Copies of the form may be obtained from Mr. E. E. White, 140, Battersea Park Road, London, S.W.11. Forms when completed should be returned to the Chemical Research Laboratory at Teddington.

Industrial Production Rises

The index of industrial production in June is provisionally estimated at 149 (1946 = 100), an increase of six points over the revised May figure. In June, 1950, the index was 143. Prepared by the Central Statistical Office, the index shows that in the mining and quarrying industries the June figure of 117 showed an increase of one point over the previous month and a gain of nine points on the year.

The index in the manufacturing industries rose from 149 in May to 157 in June, the figure for June, 1950, being 138.

Association of Bronze & Brass Founders. An informal meeting of members in the London area is to be held at the Clarendon Restaurant, Hammersmith, London, on Thursday, September 20, commencing with luncheon at 12.45 p.m.

Raw Material Markets

Iron and Steel

Pressure for supplies of pig-iron from the foundry trade continues heavy, demands being much in excess of production. All grades of foundry pig-iron and hematite are difficult to acquire. Although licensed tonnages have been restricted by the control authorities, it is generally impossible to secure even the reduced quantities, and many furnaces are operating a rationing system of their own in an effort to attain the fairest possible distribution of available supplies. Stocks at both the foundries and the furnaces have been largely liquidated; so that everything is dependent upon current production.

An early improvement in the position is very unlikely, as, apart from the needs of the foundries, the steelworks also require larger quantities of steelmaking pig-iron, and the blowing-in of fresh units is precluded by the shortage of raw materials. In fact, many furnaces now in blast are not receiving sufficient raw material to enable them to obtain maximum outputs.

The general engineering, motor, and textile foundries are using up all the low- and medium-phosphorus iron and hematite they can obtain, while refined iron and Scotch foundry pig-iron are also accepted when available. The light and jobbing foundries are in need of larger quantities of high-phosphorus pig-iron. The shortage of scrap is a further handicap; most foundries are in need of bigger supplies of both cast-iron and steel cupola scrap. The demand for machinery cast-iron and ordinary heavy cast-iron scrap is particularly urgent.

Deliveries of foundry coke are generally sufficient to meet current needs, but stocks are not being built up at all satisfactorily. Ganister, limestone, and firebricks continue to be available to requirements, but difficulty in obtaining some grades of ferro-alloys persists.

Available supplies of steel semis from home steelworks do not enable the re-rollers to improve on their current restricted outputs. The position can only be eased by increased supplies of imported semis. Orders for all re-rolled products are plentiful, deliveries to consumers and stockists falling well short of their requirements. Sheet re-rollers are also inundated with business; they need larger quantities of sheet bars, and, to ease the situation, all arisings of defectives and crops are being accepted.

Non-ferrous Metals

The usual monthly figures have been published by the British Bureau of Non-ferrous Metal Statistics and these show a moderate decrease in activity during July. Stocks of copper were rather higher at July 31, for the June figure of 116,907 tons increased to 120,336 tons, of which some 102,000 tons were in the form of refined metal, the balance being blister copper. Consumption in July was 43,759 tons, compared with 46,784 tons in June. In both these months the proportion of scrap was between 19,000 and 20,000 tons, while virgin copper in July was 24,000 tons compared with 27,663 tons in June.

Stocks of zinc at the end of July were 34,506 tons compared with 34,221 tons a month earlier, while consumption, virgin and secondary, was 22,605 tons against 23,312 tons in June. Usage of lead in July fell rather sharply from 29,898 tons in June to 26,136 tons in July. This compared with 30,298 tons in May. Stocks of lead at July 31 amounted to 27,595 tons which was an increase of about 2,000 tons on June 30. In tin the U.K. consumption was 1,867 tons. Usage of this metal has shown a drooping tendency of late, for the May figure was 2,263 tons.

Owing to the issue of an injunction against the International Union of Mine, Mill and Smelter Workers, the nation-wide strike in the United States is likely to be brought to a conclusion. Already serious losses in output of copper, lead, and zinc have occurred, and at a time when the country can ill afford to see any reduction made in domestic production. Imports from overseas sources have shown a fall this year compared with last, and the duty on foreign zinc entering the country is likely to be lifted.

It would appear that plans are in course of preparation whereby the U.S. Government will purchase non-ferrous metals on the world market, at the best prices obtainable, for resale to American consumers. This would be in line with the avowed intention of the U.S. Government to secure adequate supplies without inflating prices at home. It must, however, inevitably result in keeping up values on the world market which once or twice lately have shown a disposition to move down. For the present, stockpiling in the States has been virtually abandoned, both as to further buying and as to deliveries to the strategic reserve. So far as copper is concerned there has been a 25,000-ton withdrawal, and more may follow.

London Metal Exchange official tin quotations were as follow:—

Cash—Thursday, £970 to £980; Friday, £975 to £985; Monday, £955 to £957 10s.; Tuesday, £950 to £955; Wednesday, £930 to £940.

Three Months—Thursday, £927 10s. to £930; Friday, £920 to £925; Monday, £907 10s. to £910; Tuesday, £912 10s. to £917 10s.; Wednesday, £887 10s. to £890.

Correspondence

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

PLASTIC FLOW IN MOULDING SANDS

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—On reading over your publication of my report on flowability measurement in last week's issue I have found one or two errors. On page 273, modulus of plasticity is stated as being equal to $\frac{\text{ultimate stress}}{\text{ultimate strain}}$ this is incorrect and should be simply $\frac{\text{stress}}{\text{strain}}$. Obviously the values taken must be within the straight-line portion of the graph, as otherwise the ratio conveys little meaning: $\frac{\text{ultimate stress}}{\text{ultimate strain}}$ is the modulus of rupture.

On the same page, the flowability of a sand with 2 per cent. moisture is stated as 79·3 × 10 lb. per sq. in. per in. This should read $79{\cdot}3 \times 10^{-4}$ in. per in. per lb. per sq. in., and these units should be used for flowability throughout that paragraph and also in Figs. 7, 10, and 11. In Figs. 12 and 13 they are reported correctly.

Flowability is the reciprocal of plasticity and as the units of the latter are lb. per sq. in. per in. per in. then the units of the former must be in. per in. per lb. per sq. in., *i.e.* inches of deformation per inch of length per pound of load per square inch of cross-sectional area.

Yours, etc.,

A. JAMIESON.

MR. R. W. TAYLOR, A.M.I.E.E., takes up an appointment on October 1 with Crompton Parkinson Limited, as product sales manager of the Nelson stud-welding service.

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

(Delivered, unless otherwise stated)

September 12, 1951

PIG-IRON

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

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

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

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

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

Cold Blast.—South Staffs, £17 5s. 6d.

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

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

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

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered.)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—Basic: Soft, u.t., £21 11s. 6d.; tested, 0 08 to 0.25 per cent. C (100-ton lots), £22 1s. 6d.; hard (0.42 to 0.60 per cent. C), £23 19s.; silico-manganese, £29 15s.; free-cutting, £24 15s. 6d. Siemens Martin Acid: Up to 0.25 per cent. C, £27 16s.; case-hardening, £28 4s.; silico-manganese, £30 16s. 6d.

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

Sheet and Tinplate Bars.—£21 16s.

FINISHED STEEL

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

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

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

Tinplates.—54s. 8¼d. per basis box.

NON-FERROUS METALS

Copper.—Electrolytic, £234; high-grade fire-refined, £233 10s.; fire-refined of not less than 99.7 per cent., £233; ditto, 99.2 per cent., £232 10s.; black hot-rolled wire rods, £243 12s. 6d.

Tin.—Cash, £930 to £940; three months, £887 10s. to £890; settlement, £935.

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

Lead.—Good soft pig-lead (foreign) (duty paid), £180; ditto (Empire and domestic), £180; "English," £181 10s.

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

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

Brass.—Solid-drawn tubes, 25½d. per lb.; rods, drawn, 33¼d.; sheets to 10 w.g., 30⅛d.; wire, 31¼d. rolled metal, 28⅞d.

Copper Tubes, etc.—Solid-drawn tubes, 26⅞d. per lb.; wire, 261s. 9d. per cwt. basis; 20 s.w.g., 288s. 9d. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £277 to £281; BS. 1400—LG3—1 (86/7/5/2), £282 to £300; BS. 1400—G1—1 (88/10/2), £330 to £360; Admiralty GM (88/10/2), virgin quality, £350 to £360 per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £355 to £390; L.P.Bl, £316 to £322 per ton.

Phosphor Bronze.—Strip, 38⅞d per lb.; sheets to 10 w.g., 40⅞d.; wire, 43⅜d.; rods, 38⅞d.; tubes, 37d.; chill cast bars: solids 4s., cored, 4s. 1d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Ingots for raising, 2s. 7½d. per lb. (7%) to 3s. 7½d. (30%); rolled metal, 3 in. to 9 in. wide × .056, 3s. 1½d. (7%) to 4s. 1½d. (30%); to 12 in. wide × .056, 3s. 1¾d. to 4s. 1¾d.; to 25 in. wide × .056, 3s. 3¾d. to 4s. 3¾d. Spoon and fork metal, unsheared, 2s. 10¼d. to 3s. 10¼d. Wire, 10g., in coils, 3s. 7¼d. (10%) to 4s. 7d. (30%). Special quality turning rod, 10%, 3s. 6¼d.; 15%, 3s. 11d.; 18%, 4s. 3¼d. All prices are net.