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Belated Priority

Foundrymen possessing foresight will not regard with complacency the opinion expressed by "The Times" that the production of iron and steel will be lower this year by 1¼ million tons. They will know that their output follows much the same trend as steel, since every piece of steel incorporated into an article of commerce demands its quota of castings for completion. The Ministries are more optimistic than "The Times", yet they are sufficiently perturbed to have announced, somewhat belatedly, a scheme of priority which will ensure that rearmament orders receive preference. These are to be labelled D.O., whilst others demanding preferential treatment will carry the letters P.T. It would appear that this scheme is not mandatory, but being quite sensible it will command the sympathetic co-operation of industry.

The main items which will come under this allocation scheme are steel (including castings) and the non-ferrous metals, but not iron castings. Here the position is indeed curious, for since the beginning of the year we have been informed—often backed by incontrovertible evidence—that shortages of raw materials were having a deleterious effect on production, yet statistically during the first quarter of the year, production rose from last year's record figure of 3½ million tons per annum to a yield averaging 3¾ million tons a year. During the second quarter, the monthly statistics show that employment is increasing. Thus it is obvious that ministerial opinion is that there is, under such circumstances, no need for action.

We are not satisfied that in every case raw material shortages really exist on a global basis. In some instances the productions have in recent times approached record proportions. If this country missed the correct moment for buying, it was just lack of foresight. In the past, even quite small iron foundries believing the market for pig-iron was likely to harden, would buy more than their current requirements demanded and leave it to the merchants to finance the deal. It would seem that the American authorities decided to stock pile, and left this country in a state of short supply. There is obviously a temptation to defer buying when prices are rising, but there should be a realisation that to keep this country on an even keel, non-ferrous metals and the like are as essential as beef. However, it is no good grumbling over spilt milk, and we can assure the Government that the foundry industry will do its best to ensure that the new allocation scheme is honoured. On paper, at least, it looks much better than "M" forms; so long as the departments do not over-indent in the hope of getting a fractional proportion, then real co-operation can be assured.

New Priority Schemes

The Government has decided on three measures to control the use of scarce metals. They were announced by Mr. Hugh Gaitskell, Chancellor of the Exchequer, in the House of Commons on June 28.

First, allocation schemes are being prepared for iron and steel (other than sheet steel and tinplate, which are already subject to allocation) for introduction as soon as possible and corresponding measures to regulate the distribution of the more important of the scarce non-ferrous metals will also be worked out.

Secondly, since it will take some time to get these schemes introduced and working effectively, certain interim measures will be brought into operation so as to safeguard the defence programme meanwhile. For this group the letters D.O. will indicate priority.

Thirdly, not only the defence programme, but various categories of civilian production must be safeguarded while the allocation schemes are being worked out. These categories include dollar and sterling area exports and the fuel and power programmes, which remain as important as ever they were. Proposals are, therefore, being worked out whereby sponsoring departments will be able to claim preferential treatment for specific orders for goods for which iron, steel (other than those already allocated), and copper, zinc, and their alloys are required, subject to a strict limit on the amount qualifying for such preferential treatment in any particular period (P.T. priority).

Finally, said the Chancellor, it must be emphasised that the interim measures for civilian production are intended to apply only to a small number of cases of particular importance or difficulty. Over the rest of the wide field of metal-using industries the Government must meanwhile continue to look to industry—both manufacturers and material suppliers—to do their best to make sufficient material available for those purposes which, in the light of the general guidance given by the Government, are known to be important. In cases of special difficulty, or of doubt about the degree of importance of an order, reference could be made to the production department.

Forty Years Ago

In the FOUNDRY TRADE JOURNAL of July, 1911, Dr. Richard Moldenke raises the question of the standardisation of transverse test-bars for cast iron. It seems that there had been held a conference on testing of metals at Copenhagen when a bar 14 in. long 1¼ in dia., broken between 12 in. centres had been put forward. The lifting magnet is so generally taken for granted nowadays, that an article on the subject seems strange. Apparently there are eight potential advantages—one of which is a series of trips over the sand floor to rid it from metal splashings. Somehow this one does not appeal to us. There is a note on a two-day conference on the Education and Training of Engineers. If the Papers were reprinted to-day, would they differ much from modern contributions to the subject? The titles at least sound appropriate! According to an advertisement one could buy a fully automatic 3-ton per hour sand-preparing plant for £485.

A SCHEME for "pairing" part-time married women workers, so that their domestic affairs can be properly looked after, has been introduced by the Villiers Engineering Company, Limited, Wolverhampton. While one is working on a shift, her "paired" friend is free to look after both homes. Forty per cent. of the company's labour force is composed of women.

Foundry Coke Merchants' Association

The tenth Annual General Meeting of the Foundry Coke Merchants Association was held at the Waldorf Hotel, London, on June 21. The meeting was preceded by lunch at which the guests of the Association were Mr. C. F. Sullivan, Mr. W. Armstrong, Mr. R. H. Grierson and Mr. K. Bedbrook of the National Coal Board and Mr. C. Hardwick of the Ministry of Fuel and Power. Mr. Arnold Carr of Thos. W. Ward, Limited, was re-elected chairman and member firms elected to fill the vacancies on the Committee were J. C. Abbott & Company, Limited, Darby & Company, and Chas. B. Pugh (Walsall), Limited. Mr. S. Owen was elected secretary and treasurer in place of Mr. A. Dudley Evans who had been compelled to resign owing to ill-health, having served the Association in that capacity since its inauguration. In his report the chairman referred to the cordial relations which existed between the Association and the N.C.B. and to the great success of the annual dinner which was held at the Mayfair Hotel in February and at which both the N.C.B. and foundry coke consumers were well represented. It was agreed that the next annual dinner be held in February, 1952.

Industrial Civil Defence

General plans for the organisation of civil defence in industrial and commercial premises are outlined in a Home Office publication, "Civil Defence Industrial Bulletin No. 1" (H.M. Stationery Office, price 6d.), copies of which are being sent to all establishments in important built-up areas employing more than 200 people. The first object is to enable such establishments to have at their disposal trained forces to supplement the resources of the public civil defence services. The Home Office and the Scottish Home Department will have the main responsibility for the supervision of plans for services, including the provision of shelters, fire protection arrangements, camouflage, black-out, and the warning system.

Liaison with the local authorities is stressed and as a first step it is suggested that each establishment appoints a full-time or part-time officer to be responsible for civil defence organisation, to draw up a scheme, and to recruit and train personnel.

On the question of expenditure incurred in making these arrangements the bulletin says that it will be classed as "revenue" expenditure, and will be admissible as a deduction in computing trading profits for income-tax.

Instrument Maintenance Mechanics

The City and Guilds of London Institute announces the adoption of an important new scheme of courses and examinations in instrument maintenance, which has been drawn up by an authoritative advisory committee including representatives of industry, the Society of Instrument Technology, the Ministries of Supply, Fuel and Power, and Education, the Service Departments, major engineering professional institutions, and associations concerned with technical education. The scheme is intended to meet the needs of mechanics and technicians concerned in the maintenance, repair and installation of the instruments used for process and production control in industrial plants, particular attention being given to the requirements of the chemical, iron and steel, and allied industries. The course of part-time study is of five years duration.

Synthetic Resins in the Foundry*

Report and Recommendations of Sub-committee T.S.30 of the I.B.F. Technical Council

Constitution of Sub-committee T.S.30

G. L. Harbach, A.I.M., chairman (also representing the Association of Bronze & Brassfounders), B. Abbott (Gardom student), J. M. J. Estevez, B.SC., A.R.I.C. (representing British Plastics Federation), E. L. Graham, H Greatorex, J. Hill, A. R. Martin, B.SC., A.R.S.M (representing Light Metal Founders' Association), G. W. Nicholls, W. B. Parkes (representing British Cast Iron Research Association), P. G. Pentz, B.SC. (representing British Plastics Federation), S. A. Perry representing British Plastics Federation), L. W. Sanders, A.I.M., A. Tipper, M.SC.(ENG.), F.I.M., G. Lambert (secretary to the Committee).

Terms of Reference

Sub-committee T.S.30 was appointed in March, 1949, to investigate the use and development of synthetic resins for:—

(*a*) Core binders;
(*b*) moulding sands;
(*c*) other foundry applications,

in connection with the production of ferrous and non-ferrous castings. These terms of reference, with the Technical Council's concurrence, were interpreted to exclude impregnation. As explained later, the report has been confined to the use of synthetic resins in the production of cores, as all evidence which became available to the Sub-committee indicated insufficient activity in other directions to warrant inclusion.

In forming the Sub-committee, the Technical Council had in mind the amplification on a practical basis of certain investigatory work carried out during the preceding two years on behalf of the Joint Standing Committee on Conditions in Iron Foundries and the Technical Committee of the Association of Bronze and Brass Founders.†

The constitution of the Subcommittee, which is detailed separately, embraced members of the Institute known to have experience of the subject, together with representatives of the British Cast Iron Research Association, the Light Metal Founders' Association, the Association of Bronze and Brass Founders to ensure that foundry interests were covered on as wide a basis as possible, and representatives of the British Plastics Federation to provide technical data on the manufacture, properties and foundry applications of synthetic resins

Introduction

In the view of the Sub-committee both experimental and production experience was available in this country on synthetic-resin core-binders and possibly other uses. With a view to collecting and summarising this information, a questionnaire was devised and circulated to foundries believed to have knowledge of the subject. It was anticipated that conclusions could be drawn from the replies regarding the advantages, disadvantages and limitation of the use of synthetic resins in foundries. It was decided that these conclusions should be considered in relation to the following aspects:—

(*a*) *Technical:* Covering mixing, core-making, life after mixing and air drying properties, adequacy of green and dry strengths, flexibility of baking conditions, friability, gas content, ease of knock-out and casting skin.

(*b*) *Economic:* To include materials, fuel, labour and time.

(*c*) *Comfort and Health:* Dealing with objectionable or harmful fumes when mixing, coremaking and casting; the possible danger of dermatitis, and the importance of endeavouring to implement the recommendations of the Report of the Joint Advisory Committee on Conditions in Iron Foundries (Garrett Report).

The replies to the questionnaire provided considerable information, but the British Plastics Federation representatives felt they did not cover the whole of the experience available as they had knowledge of foundries who had not replied, but were known to be using synthetic resins on a production scale. They undertook amplification of the original findings with information available to them as suppliers. The Sub-committee's Report is therefore based on a combination of the replies to the Institute questionnaire, the report from the Federation's representatives, and the practical experience of members of the Sub-committee.

No evidence was provided to show that synthetic resins were used as additions to moulding sands. Other foundry applications, some established and some experimental, are known, but the information obtained dealt almost exclusively with the use of synthetic resins as core-binders, and this report is therefore confined to section (*a*) of the terms of reference.

* Report presented at the Newcastle-upon-Tyne Conference of the Institute of British Foundrymen.

† "Synthetic-resin Corebinders," by G. L. Harbach. Proceedings of the Institute of British Foundrymen. Vol. XLII, pp. B30-B44.

Synthetic Resins in the Foundry

Properties of Synthetic Resins as Core-binders

Several different classes of synthetic resin have been proposed and tested as core-binders; phenolic (phenol- or cresol-formaldehyde, known generally as P.F.) resins; urea (urea-formaldehyde or U.F.) resins; melamine (melamine-formaldehyde or M.F.) resins; resorcinol resins; polyester resins; methyl cellulose, and others of less importance. Of these, only the P.F. and U.F. resins have been used in practice on a large scale; though melamine resins have found some use, particularly in Switzerland, in spite of their much higher cost, and methyl cellulose has been employed on the Continent with some success in light-alloy foundries, where low dry-strength is not a serious disadvantage. It appears unlikely that the plastics industry will be able to provide, in the predictable future, any new classes of synthetic resin possessing the valuable core-bonding properties and moderate cost of the U.F. and P.F. resins, and attention is, therefore, concentrated on these two classes.

Urea-formaldehyde Resins

U.F. resins are available both as liquids and in solid form as dry powders, which may consist entirely of resin, or may contain controlled proportions of cereal or other ingredients to provide green strength. The liquid resins tend to be somewhat cheaper (on a basis of equal resin-solids content) and are more widely used. They usually contain 50 to 70 per cent. resin solids, the balance being mainly water. Bonding strength is roughly proportional to the resin-solids content, but other factors may have a substantial influence, and cost comparisons should be made only on the basis of total binder costs for a given quantity of mixed core sand.

Many different grades of U.F. resin are available, and the properties of importance in foundry work may vary substantially between one grade of resin and another. Uniform and constant quality can, however, be expected in any one grade.

Among the liquid U.F. resins, differences may be found in resin content, viscosity, stability during storage, excess formaldehyde odour (apparent during sand mixing), and effect on green-strength. The more important properties common to all U.F. resin binders are:—

(1) In use they are permanently changed by heat alone, or by the use of chemical catalysts, into hard infusible solids, practically unaffected by moisture. This change does not require the presence of air, and is largely independent of sand permeability or of air circulation in baking ovens.

(2) The baking time required to effect this "curing" or hardening of the resin is much shorter than for linseed or similar core-oils—usually about half as long. Curing of the resin may be effected at temperatures ranging from room temperature to about 170 deg. C. Above this temperature, the resin will begin to decompose. It should be noted, however, that this refers strictly to the temperature of the core itself and higher stove temperatures are used in practice (see section on baking).

Reduction in baking time appears to be one of the most important advantages offered by U.F. resin binders for general foundry work.

(3) U.F. resins are especially suitable where high-frequency heating can be used for baking the cores, since they can be cured extremely rapidly, with a minimum consumption of high-frequency power, and without any possibility of over-baking. Provision should be made, in designing the high-frequency oven, for ventilation to remove the water vapour and lachrymatory formaldehyde gas evolved by the resin during the curing process.

(4) The U.F. resins normally contain "free" or excess formaldehyde; those manufactured specifically for use as core-binders are usually so made as to reduce this to the lowest practical level, thus effectively preventing the development of unpleasant formaldehyde fumes during the mixing of the core sand. If the sand is hot, however, or its temperature is raised sufficiently by friction in the mixer, formaldehyde may be generated to a noticeable and inconvenient, though not dangerous, extent. During baking of the cores it is inevitable that relatively large quantities of this gas will be evolved, but these would normally be carried away with other oven gases in the oven ventilation system, and so present no problem. *Completely* baked cores in which the resin has been fully cured, have no detectable odour of formaldehyde.

(5) All U.F. resins break down rapidly at casting temperatures, even at the relatively low temperatures reached by cores in light-alloy castings. This characteristic leads to two outstanding advantages of this type of binder, and to one necessary limitation on its use: *viz*: excellent knock-out properties, and freedom from hot-tears or cracks in light-alloy or malleable-iron castings in thin sections, even when cores have high dry-strength; but some danger of premature core collapse when used in heavy steel or iron castings. Where rapid breakdown of binder is of major importance, U.F. resins are undoubtedly far superior to linseed and similar core oils, and to P.F. resins.

(6) All U.F. resins, under conditions which cause partial decomposition by heat, but not complete combustion, produce odours which are generally regarded as rather unpleasant, but which do not appear to be associated with any harmful effects on health. Such conditions exist in core ovens if baking is excessive, and over-baked cores can be recognised by their characteristic "burnt-fish" smell. Since such over-baked cores have reduced strength and surface hardness, this would point to the need for better control of baking conditions. The odour problem is, therefore, confined in practice to the "smoking-off" period after casting, and to the knock-out operation. It is emphasised that this type of odour *is charactertistic of all U.F. resins.* Remedial measures consist chiefly in the use of the lowest proportion of U.F. resin in the core sand to give the necessary strength, the hollowing out or filling with coke, etc., of the interiors of large cores and special ventilation at smoking-off and knock-out stations.

Some reduction in the amount of *smoke* after casting is observable when oil compounds are replaced by U.F. resins.

(7) Gas evolution from U.F. resins during casting differs from that experienced with linseed-oil preparations, mainly in the rate rather than in the quantity evolved. In the initial stages of its decomposition a core bonded with resin evolves gas at a considerably higher rate than an oil-bonded core. This does not seem in practice to cause any difficulty, though in certain cases extra venting may be desirable.

(8) Stability of U.F. resins during storage varies quite widely. Powdered resins, if kept dry and reasonably cool, will remain practically unchanged for a year or more. Liquid U.F. resins usually thicken slowly during storage, but remain suitable for use over periods ranging from one month to nine months or more, depending on the particular grade of resin, provided they are stored in a cool place (preferably below 70 deg. F.). Resin suppliers can specify the storage life to be expected from each of their individual products.

(9) The effect of moisture in the mixed core-sand on the dry-strength and surface hardness produced by U.F. resin binders is very pronounced; both these properties in the baked core improve greatly as moisture content is raised. They usually attain maximum values at a moisture content of 4 to 6 per cent. This is probably the result both of improved distribution of the resin during mixing, and of some migration of resin from the centre of the core, providing extra strength and hardness at the surface. In practice, it may be impossible to use so high a moisture content, because increase in moisture above a certain level (which varies with the nature of the sand, and the amounts of cereal, clay—if any—and resin in the mix) causes a severe increase in the tendency of the sand to stick to coreboxes, etc. To some extent, this can be overcome by the addition of lubricants, parting compounds, etc., and/or by suitable treatment of coreboxes. Substantial economies in resin consumption can be effected by working at the highest practical moisture content in the green core-sand.

(10) It follows that where, as is usual, a cereal binder is used to provide green strength and plasticity, the type of cereal chosen should be such as to tolerate as high a moisture content as possible. For this reason, cereals like pre-gelatinised starch, flour, etc., are generally preferred to dextrin for use with resin binders.

Some synergistic action appears to take place between the resin and the cereal, whereby a combination of the two gives greater strength to the baked cores than would be expected from the performance of either alone.

(11) The U.F. resins, and the raw materials from which they are made, are entirely of British manufacture. Ample supplies are available.

Phenol-formaldehyde Resins

Phenol-formaldehyde resins are available, like U.F. resins, both as dry powders and as liquids usually containing 50 to 70 per cent. solids. The P.F. resins may be made from phenol or from its various homologues, and a large number of different types and grades may be supplied for foundry work. Comparisons should be based on performance in relation to total binder costs.

The various grades of P.F. resin can be expected to differ in resin content, viscosity, stability during storage, "free" formaldehyde and effect on core strength properties. Properties common to all P.F. resin binders are:—

(1) They are thermosetting (see under U.F. resins paragraph (1)). After curing they are even less affected by moisture than U.F. resins.

(2) Baking time required to effect curing of the resin is about the same as for U.F. resins, but a slightly higher temperature is usually desirable. A difference of major importance is that P.F. resins are very much less sensitive to baking conditions than U.F. resins. In fact, their resistance to over-baking is approximately equal to that of linseed oil. While it is usually possible, therefore, to bake P.F. resin-bonded cores under the same conditions as oil-bonded cores, the oven temperature can often be reduced with advantage, and the baking time can usually be halved.

Certain types of P.F. resin may be cured at room temperature through the use of suitable acid catalysts, but they are not usually recommended for core-binding. It is normally necessary, therefore, to raise the temperature of the resin in the core to about 150 to 175 deg. C. in order to effect the hardening of the resin in a reasonably short time. Above 175 deg. C. the resin will begin to break down, though more slowly than a U.F. resin. Optimum oven temperature is usually about 430 deg. F. (220 deg. C.). As with U.F. resins, the saving in baking time and fuel is one of the chief advantages offered by P.F. resin binders.

(3) The P.F. resins react well to high-frequency heating and, like U.F. resins, may be cured extremely rapidly by this means. The power required is, however, usually rather higher than for U.F. resins.

(4) The P.F. resins normally contain some excess formaldehyde which may be noticeable during the mixing operation if the sand is, or becomes, hot (see under U.F. resins, paragraph (4)). Formaldehyde is necessarily evolved during baking, but this should present no difficulty in practice, given normal oven ventilation. Completely baked cores have no detectable odour of formaldehyde.

(5) The P.F. resins usually break down after casting at about the same rate as oil binders; therefore, when used in cores for light-alloy, for thin iron or malleable castings, cores should not be made too strong. (Note difference from U.F. resins—see earlier paragraph (5).)

(6) The odours produced by P.F. resins after casting are generally agreed to be less in quantity, and less obnoxious, than those from other types of binders, including oils. The amount of smoke produced is also less than from core oils. These constitute a definite advantage for P.F. resins as core binders.

(7) Both the amount and the rate of gas evolution from P.F. resins are lower than from either U.F.

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resins or linseed oil. Where low gas content is advantageous, P.F. resins may offer distinct advantages over other types of binder.

(8) The stability of P.F. resins during storage is much the same as that of U.F. resins (see under U.F. paragraph (8)).

(9) The importance of moisture content in the mixed sand is the same for P.F. as for U.F. resins (see U.F., paragraph (9)).

(10) The need for choosing a suitable type of cereal for use with P.F. resins is exactly the same as for U.F. resins (see U.F., paragraph (10)).

Like U.F., P.F. resins with cereal binders impart strength properties which are more than additive.

(11) P.F. resins, and all the raw materials from which they are made, are entirely of British manufacture. Large production facilities exist, and no difficulty is anticipated by the resin manufacturers in supplying the needs of the foundry industry.

Modifications of U.F. and P.F. Resins

While it seems unlikely that other classes of synthetic resin will be important as core-binders, it may well be that modifications of U.F. and P.F. resins, possibly by blending with other bonding agents, may be effected by the manufacturers with benefit to core-making properties.

FOUNDRY APPLICATIONS

(a) General

Of the 40 replies to the questionnaire, 30 foundries reported experience of either or both U.F. and P.F. resins as core-binders, U.F. resin being the most commonly used. Six foundries, following successful trials, were seriously considering their use on a production scale and a further six had already adopted them as standard practice. Satisfactory results were reported for widely varying weights and sections in cast iron, steel, malleable cast iron, copper-base alloys and light metals.

The following summarises the information obtained from the replies to the questionnaire, the report from the representatives of the British Plastics Federation, and the practical experience of members of the Sub-committee:—

Mixtures.—Silica sands are normally used with, in some cases, clay additions either as naturally bonded sand—up to about 20 per cent.—or as bentonite or other colloidal clays up to about 0.5 per cent. The advantages of adding clay are that it reduces or prevents stickiness in mixtures of high water content, increases green-strength to prevent sagging and retards collapse when pouring heavy-section castings. Clay additions have the usual disadvantages of reducing dry-strength and increasing friability; if an addition of red sand is made in order to introduce clay, there is also a reduction in permeability.

The general range of liquid resin content is 0.5 to 3 per cent., with a cereal binder of the starch type from 1 to 2 per cent., the higher proportions of resin or cereal being necessary when substantial amounts of clay are present. Moisture varies from 1 to 5 per cent., increasing with the clay and cereal contents. To reduce stickiness and improve flowability, paraffin or other liquid parting agent from $\frac{1}{4}$ to $\frac{1}{2}$ per cent. is frequently added. Various chemical catalysts or other special ingredients, such as hexamine, boric acid or certain acid salts may also be added (in consultation with the supplier of the resin) to achieve particular effects.

Mixing.—Mixing practice generally follows that for oil-sand. The dry constituents may be added to the sand, followed by the liquids, but in certain cases it may be advisable to add the water and resin before the cereal powder. It may sometimes be necessary to mix a somewhat smaller batch than for oil-sand practice. Mixing time varies according to the type of mixer, usually from three to six minutes.

The presence of lachrymatory fumes during mixing is accentuated by the use of hot sand, but the degree appears to depend partly on the type of resin used and partly on the temperature attained during mixing.

Bench Life: Air-drying Properties and Coremaking.—In some cases bench life is stated to be poor, but one large user on full production has claimed that bench life is better than with oil-sand. In general, there appears to be little difference. The deciding factors are the mixture used (particularly the presence or absence of catalysts capable of curing the resin at shop temperature), and the moisture content of the mixed sand.

In certain mixtures of resin-bonded sand, especially those of high permeability, air drying is more rapid than for oil-sand. This may cause considerable difficulty, particularly with small cores, because it leads to lower dry strength and friability of the baked cores, unless prevented by spraying or other treatment before baking.

As regards sticking of sand to rammers, coreboxes and strickling tools, it has been noted that under conditions of high atmospheric humidity the mixed resin sand may become sticky. However, this can be prevented by suitably adjusting the moisture content and possibly by increasing the proportion of parting medium in the sand mixture. Coremakers should not wipe coreboxes with linseed oil as a parting medium.

Core blowing with resin-bonded sands is possible, though some modification to increase flowability is advisable, such as reducing moisture and clay contents and the addition of fuel oil or other lubricant.

If blacking is practised, cores can be sprayed green and are subsequently ready for immediate use after baking. This also helps to protect the surface against the effects of over-baking. If blacking is not normally used, then cores may be sprayed with water or a 10 per cent. resin solution, to provide an extremely hard skin. A similar resin solution may be used in blacking mixtures in preference to an oil addition. Resin cores may be jointed by the usual accepted methods, *i.e.*, pasting or lead jointing.

Baking.—When not baked alongside oil-bonded cores, reduced baking time and temperatures appear to be general practice. Oven temperatures between 150 and 250 deg. C. (300 and 480 deg. F., approximately) are commonly used, but with U.F. resins at temperatures above 175 deg. C. (350 deg. F.) serious loss in core strength may occur unless the baking *time* is adjusted and closely controlled in relation both to the oven temperature and to the dimensions of the cores baked. Oven temperatures much above 175 deg. C. are in practice unsuitable for U.F. resins unless all the cores in each oven charge are of about the same size, and are roughly uniform in sectional thickness; otherwise smaller cores or thin sections will be seriously over-baked before thicker portions are adequately cured. For small cores the use of a baking temperature of 150 deg. C. does not lengthen to any marked extent the baking time required. Oven costs may be reduced through savings in fuel and oven maintenance. Similar considerations apply to P.F. resins, though, as noted earlier under P.F. resins, these are much less susceptible to over-baking than U.F. resins. Because of the adverse effect of air-drying on dry-strength, as mentioned above, better results are obtained by introducing cores into a hot oven, than by heating up slowly from cold.

Efficient oven ventilation should be provided to remove the lachrymatory fumes of formaldehyde emitted during baking.

Dimensional Accuracy.—In general, the dimensional accuracy obtained when using resin cores is claimed to equal that obtained when using oil-bonded cores, but two users, working to close limits, find evidence of slight contraction as certain cores show a small amount of sag, although no bulge appears at the base; in contrast, a slight expansion has been experienced by another user. It may be necessary in certain cases to alter equipment to suit the physical properties of the sand.

Storage of Cores.—Resin-bonded cores do not deteriorate more than oil-sand cores during storage. Damage during handling may result in certain cases due to a tendency to brittleness. Experience indicates that no serious damping back occurs in green-sand moulds.

Casting Fumes.—Practically all users of U.F. resins complain of a fishy odour when casting and at the knockout, some claiming the fumes to be more disagreeable than those from oil-sand cores, others stating that, once acclimatised, they suffer no discomfort from the fumes and find them preferable to oil-sand fumes.

Users of P.F. resin find much less fume than with oil-sand and no objectionable odour.

Knock-out.—Agreement is unanimous that U.F. cores given excellent knock-out properties—cores collapse completely even in castings of thin sections. P.F. resin cores are reported as equal to, or better than, oil-sand cores but not equal to U.F. resin in this respect.

Casting Finish.—No definite conclusion can be drawn on this point, but there is general agreement that the casting finish obtained when using resin cores is not inferior to that obtained when using oil-bonded cores—much appears to depend on the core mixtures, the metal used and the casting temperature. A few users of U.F.-resin cores find less tendency to finning.

(b) Ferrous

(*i*) *Cast Iron: General.*—Both U.F. and P.F. resins have been used for bonding cores for iron castings. Because of their lower and less rapid gas evolution, phenolic resins can be used with advantage on castings where the core is almost completely surrounded by metal *e.g.* jacket cores for cylinders and cylinder heads, etc.

Precautions.—Experience with resins for cast iron (which may also apply equally to other metals) has shown that several practices, which are widely used by core-makers and core-setters when using oil-sand, should be suppressed when using resin-bonded cores. For examples:—

(*a*) The rubbing of core surfaces for the purpose of removing the hard skin, the latter being said to prevent the metal flowing evenly over the core.

(*b*) The re-blacking of cores which have been rubbed. This tends to cause slight scabbing, due either to the blacking peeling under the flow of metal or the resin being burnt by excessive torch drying.

In any case, the rubbing of resin-bonded cores is undesirable, as the exposed surface tends to be friable.

(*ii*) *Steel.*—On the basis of a statement received from the British Steel Founders' Association, it can be said that, while a small number of steelfounders have made spasmodic or preliminary trials of synthetic-resin binders, they are not generally used.

(c) Non-ferrous

(*i*) *Copper-base Alloys.*—Little information is available on the use of resin-bonded cores in the production of bronze and brass castings, but it is known that both U.F. and P.F. resins have been used successfully. No difficulties peculiar to these metals have been reported and, in fact, so far as resistance to metal penetration and finning are concerned, U.F. resins hold promise of providing special advantages. The possibilities of P.F. resins have not yet been fully explored in the case of non-ferrous foundries, but should be of interest both from the fume aspect and because of the slower rate of gas evolution.

The advantage of fast curing of resin bonds in sand masses of low permeability (i.e., fine silica or clay-bonded sands) is likely to be specially useful in non-ferrous sand practice where metal penetration must be prevented and a good surface finish is important.

(*ii*) *Light Alloys.*—For light-alloy castings attention has so far been concentrated on the use of U.F. resins, because of their early breakdown and consequent good knock-out properties.

Up to the present, resin-bonded cores have not found widespread use in the light-alloy industry, due partly to difficulties characteristic of resin binders which have been dealt with under "General," and also because of the greater amount of fume after casting (due to the lower casting temperature) and to the economic aspect. Since the dry-strength generally needed in cores for light alloys is less

Synthetic Resins in the Foundry

than in cores for ferrous castings, there is frequently less economic advantage in using resins. There may, however, be other considerations such as less-friable core surface, less breakage in handling, faster baking and easier knock-out.

Economic Aspect

Binder costs in present foundry practice vary so greatly that a general comparison between resins and oils or other commonly-used binders cannot be made. It can be said, however, that U.F. resins can frequently be used to provide the required properties at an equal or lower cost. This is less often true of P.F. resins because their price, due to raw material costs, is necessarily higher. There are, however, other advantages in the use of resin binders which have economic significance, *e.g.*, increased output from core ovens and economies in fuel. Further possible economies are the elimination of re-drying of blacked cores and a reduction in fettling costs.

From the national viewpoint, synthetic resins are home-produced from indigenous materials, whereas linseed oil is obtained largely from hard currency areas.

Comfort and Health

The question of fumes from U.F. and P.F. resins has been dealt with in this report under " Properties of Synthetic Resins (U.F. paragraphs 4 and 6, and P.F. paragraphs 4 and 6)," also under the section on " Foundry Applications—*Casting Fumes.*" It should be noted that P.F. resins are better in this respect than either U.F. resins or oil binders, although, due to the presence of cereal binder in the mixture, it cannot be claimed that even P.F. resin cores are entirely free from fumes after casting. From the Committee's discussions with the Factory Department of the Ministry of Labour and National Service, there appears to be little evidence that fumes from synthetic resins present risks to health. It was emphasised, however, that the composition of the fumes is not accurately known. The Factory Department would welcome any information resulting from future foundry experience of these or other materials and complaints of ill-health, however apparently trivial, should be brought to their notice.

Good ventilation to remove fumes during baking and casting, to which attention is called in the Joint Standing Committee on Conditions in Iron Foundries' technical report, entitled " Practical Methods of Reducing the Amount of Fumes from Oil-bonded Cores," is equally desirable in the case of synthetic-resin bonded cores.

As an assessment of the risk of dermatitis to users of synthetic resins in foundries was considered to be of importance, the Committee deemed it their duty to investigate the matter as fully as possible.

In the course of exhaustive inquiries they have drawn on the experience of foundry users in this country and in the United States, on that of resin manufacturers in handling resins, and also on the knowledge and views of the Factory Department of the Ministry of Labour.

It has been established that some operatives contract dermatitis which may be associated with the use of synthetic resins as core-binders. In such cases it is advisable to withdraw such workers, whose sensitivity will be apparent during the first few weeks of exposure, and employ them on alternative duties.

As in the case of other industries using synthetic resins, appropriate information should be provided for operatives on the measures necessary to minimise the risk of dermatitis, of which one of the most important is washing. The Committee is pleased to report that the Factory Department of the Ministry of Labour and representatives of the resin manufacturers have agreed to collaborate in submitting suitable advice to the foundry industry.

It is the considered opinion of the Committee, after a very careful examination of the facts as at present known, that whilst the risk of dermatitis is not negligible, it is a hazard that calls for no restriction in the use of synthetic resins in the foundry industry. In view, however, of the paucity of the available data, the Committee wishes to stress to users the importance of establishing a check of complaints, whatever their nature, alleged to be due to a change in core-binders, so that more definite conclusions, based on the accumulated information, can be formed at a later date.

Summary

Information supplied from various sources showed that considerable interest had been displayed in the usse of urea and phenolic resins as core-binders. The result of much experimental work was revealed and a few—generally large—foundries reported satisfactory use on a production scale.

Various criticisms were made due to the different characteristics of synthetic resins as compared with oil-bonded sand and, in a number of cases, experiments had been dropped in consequence. In cases where the right type of resin was used and the necessary modifications in practice were made, results were claimed to be equal to those given by oil-bonded cores and at lower cost.

The principal criticisms were of the sticky nature of the mixed sand and lack of flowability; nevertheless, by the addition of paraffin or other parting compounds, this defect could be offset, so much so that resin-bonded sands were in satisfactory use on core-blowing machines.

Both moisture content and milling time are somewhat critical in producing the required green properties, but, given a suitable mixture of resin, cereal—and possibly clay—and adequate technical control, the resin-bonded sand could be made to be practically indistinguishable from oil-bonded sand as regards " feel," bench life and working properties.

Baked strength depends a great deal on the moisture content present when baking; therefore, if cores are allowed to surface dry before baking, weak, friable cores result, but blacking or spraying of green cores just before baking improves the strength and hardness of the core surface. However, a fairly general complaint, from large users, of brittleness, with consequent loss of cores due to chipped edges or increased fettling costs, suggests that excessive hardness is undesirable, and the ideal resin has yet to be found. Baking at 150 to 175 deg. C. for U.F. and at 200 to 250 deg. C. for P.F. is usual and, as no time for oxidation is required, normal baking times can be halved.

Damping back presents no serious problem if adequate proportions of resin are used, when the baked cores have good moisture resistance under normal foundry conditions.

Dimensional accuracy is usually satisfactory, although the results may depend in some degree on the mixture used and the precautions taken against sagging, particularly with medium to large cores.

Rubbing of cores is not recommended, as the exposed surface tends to be friable.

P.F.-resin cores have a lower gas content than those bonded with oil; U.F.-resin cores yield a quantity of gas similar to oil-bonded cores, but at a high initial rate which may necessitate additional vents.

Ease of knock-out and fettling is a characteristic feature of U.F.-resin cores, due to their complete disintegration and the reduced tendency to finning; P.F.-resin cores in these respects are not noticeably different from oil-bonded cores.

Casting finish obtained when using resin-bonded cores is not inferior to that obtained when using oil-bonded cores under similar pouring conditions.

Synthetic resins are home produced; they are also in ample supply; the cost of mixed sand is generally about the same as that of comparable oil-bonded sand; savings accrue due to reduction in baking costs and, in the case of U.F. resins, fettling costs may be reduced.

During casting, neither U.F. nor P.F. resins evolve the irritant fumes associated with oil-bonded cores, but the fumes from U.F. resin are disagreeable. The question of harmful fumes and the incidence of dermatitis have been considered very carefully by the Committee. Whilst it is realised that the risk of dermatitis is not negligible, the information available indicates that there is no reason to restrict the use of synthetic resins in foundries, as in the experience of users the number of cases of dermatitis appears to be no greater than with oil-bonded sands.

Conclusions

The interest, amongst founders, in synthetic resins for core-binding has now reached the stage where several foundries can show that advantages are real. On the other hand, some foundries have rejected synthetic resins on the score of odour and/or production difficulties.

Methods that are accepted for oil-sand must not necessarily be carried on with a changeover to resin sand, and the new binder must be treated with respect and methods adapted to suit its characteristics.

The Sub-committee are well aware of the keen interest shown and the extensive development work carried out by members of the British Plastics Federation during the past few years, and they wish to endorse that organisation's recommendation that foundries make full use of the technical services of the resin suppliers to obtain the best results from any particular type of resin.

As to implementing the recommendations of the "Garrett" Report, the Sub-committee is of the opinion that P.F. resin approaches the ideal of a practical and fumeless core binder. Nevertheless, the economic attractions of U.F. resin and the fact that fumes from the cereal portion of the mixture are inevitable, whichever resin is used, emphasise that good ventilation, together with the use of minimum percentage binder and thoroughly baked cores are the most practical means of improving conditions in foundries.

The Sub-committee wishes to thank all who have so willingly supplied data and information used as a basis of this Report.

House Organs

One Hundred and Eleven (Summer, 1951). Issued by the Hammond Lane Foundry Company, Limited, 111, Pearse Street, Dublin.

The last issue offered a prize for a statement as to what was contained in "that box" of the popular song. The award was made to Mr. T. Wickham for his suggestion that the contents were a "free travel voucher to the Salt Mines of Siberia." The issue as usual carries all the gossip of the various works in the group and a few stories.

Ad Rem (No. 2, 1951). Issued by the Butterley Company, Limited.

The reviewer learns with interest that the classical scholarship of the employees of the Butterley Company is in advance of the standard shown by customers and trade friends, who wrote expressing their ignorance of the meaning of the Latin phrase *Ad Rem*. The Editor is seeking to prove this by the inauguration of a Limerick Competition, and the reviewer looks forward to seeing the winning entries. The standard set by the first issue has been well maintained.

Malleable Iron Facts Bulletin No. 40. Issued by the [American] Malleable Founders' Society, Union Commerce Building, Cleveland 14, Ohio.

Past bulletins issued from this source have often been aggressive in the support of their own industry and this one, No. 40, carrying the caption "A Practical Appraisal of Nodular Iron and its Testing," which details the results of a research undertaken by the Author, Mr. W. W. Austin, Junr., at the Southern Research Institute, Birmingham, Alabama, is no exception. Initially an objection is raised to the comparing of results for nodular iron as derived from a keel test-bar with the standard A.S.T.M. twin bars for malleable. It is asserted that nodular iron is subject to section sensitivity, which malleable is not. The suggestion is that step-bar test castings would be a fairer test. "In extremely thin sections (¼ in. and under) the cooling rate is often sufficiently rapid to suppress graphitization to the extent that free cementite will appear in the microstructure," asserts the Author. Another statement is that "Increasing manganese content have the effect of increasing section sensitivity and retarding graphitization during annealing with resultant lower ductility."

The bulletin suggests the possibility of using nodular cast iron to extend the malleable industry's facilities to include products of heavier section. This bulletin is amongst the most interesting so far published.

Flame-cutting Steel with Propane

German Investigations

As part of a recent investigation of the economics of flame-cutting, experiments have been carried out in Germany with acetylene and propane to determine which is the more suitable gas for cutting purposes.* It is pointed out that while the physical and chemical properties of acetylene, and its preparation and applications to autogenous processing of metals have been known for decades, propane has only recently re-appeared in Germany, and is almost unknown as a welding and cutting gas.

Before and during the war, propane was supplied for domestic and industrial heating purposes and, in particular, in propane-butane mixture as a propellant. It could not be obtained immediately after the war owing to the prohibition of manufacture of synthetic propellants, but it is now available in larger quantities and is used for domestic and industrial purposes. Certain foreign papers, describing investigations into the suitability of propane for flame-cutting, have recently become available but the author of the Report states the results are confused by contradictory experimental evidence and exaggerations. A thorough examination of the problem was therefore required and experiments were designed to eliminate all doubt as to the validity of the comparison.

Oxy-propane Features

Describing the particular features of propane, the author recalls that it belongs to the same group of liquefiable hydrocarbon gases as propylene, butane, butylene and their isomers. It is obtained in Germany mainly as a by-product in hydrogenation of foreign crude oils and to a lesser degree by extraction from petroleum and coke oven gas. The flame temperature (with oxygen) of 2,730 deg. C. compared with an acetylene flame temperature of 3,120 deg. C., and the high calorific value of propane H = 2,450 B.Th.U./cub. ft. S.T.P. gave an impetus to the investigations into its suitability for producing flames for working metals. Brückner, Becher and Manthey, however, demonstrated in 1937, that calorific value alone is an insufficient criterion of the value of a gas for use in flame applications, and that rate of flame propagation is a more important factor. They used as a criterion the "specific flame efficiency" (B.Th.U./sq. in. × sec.) which depends on both factors. These investigations showed that, for the usual mixtures, the flame efficiency of various gases can be rated in the following order:—(1) acetylene, (2) hydrogen, (3) town gas, (4) propane, (5) water-gas, (6) carbon monoxide. Although propane with its high calorific value occupies only the fourth place because of its low rate of flame propagation, it is not unsuitable for use in flame cutting. Suitability of a gas which is technically satisfactory is, of course, also determined by total cutting costs, which include the cost of the gas, oxygen and wages. The only conclusion that can be drawn from the work cited is that for equal flame cone sizes, preheating with propane is slower than with *e.g.* acetylene, a result confirmed by the various authors.

As to the present author's investigations, experiments were carried out on sheets ranging in thickness from 0.4 to 11.8 in. and considerable lengths were cut with the use of the best known German makes of torches. Cutting time, gas and oxygen consumption, wages and overhead costs, based on present prices, were determined and conclusions drawn regarding the efficiency of cutting. The effect of weights which have to be transported was also considered. It was shown that acetylene is superior to propane as it requires shorter cutting times and a smaller oxygen consumption, and these are the most important factors affecting the overall costs. As, in addition, the use of propane for welding is very limited, and the author draws the conclusion that this gas is of considerably less importance than acetylene.

* H. Schulz in Mitteilungen der B.E.F.A., 1951, No. 1 (Beratungsstelle für Autogen-Technik E.V.).

Raw Materials Research

Never has the standing of the research associations been so high as it is today and their influence so great, said Mr. George R. Strauss (Minister of Supply) at a luncheon at Grosvenor House, London, on June 22, on the occasion of a conference between the Advisory Council for Scientific and Industrial Research and the chairmen and directors of industrial and nationalised research associations. Research associations, he emphasised, fulfilled a most important role in ensuring that research effort was co-ordinated and used economically. By their direct links with industry they were in a position to see that the results of research were brought before industry for application, and they could discover where more research was needed.

Research into raw materials was one of the most important problems of the day. Most materials were scarce; the needs of rearmament coming on top of a high level of industrial activity had led to demands which had in many cases outstripped the available resources, a situation which might continue for some years to come. For this reason, research associations must undertake research into new methods of conserving raw materials and try to evolve new specifications employing smaller quantities of raw materials without any lowering of essential quality. The problem of economy in the use of metals was one of course which concerned the Minister of Supply and he had appointed Mr. D. A. Oliver as Metals Economy Adviser. He was well-known to many of those present. An advisory committee, composed of experts from industry and Government departments, was being formed under Mr. Oliver's chairmanship to bring under review ways of economising in the use of scarce metals for both rearmament and civil products, and to advise how best to promote developments in this connection.

Directors of Irish Aluminium, Limited, recommend that £30,000 of undistributed profits be capitalised in issuing 30,000 new £1 ordinary shares to existing ordinary shareholders in the proportion of three new for every ordinary held. Subsequently, it is proposed to offer a further 20,000 shares to the ordinary shareholders in the proportion of one new for every two held at 20s. per share, and 20,000 preference shares to preference shareholders in the proportion of two new for every preference held at 20s. per share.

Chemical Chilling and Feeding*

By J. E. R. Tompkin, B.Met.

Strange as it may appear, it is nevertheless very true that whereas pure metallurgical research is ever tending towards the physical, the methods of the foundry floor have, of recent years, leaned towards the chemical. The best examples of these chemical trends are probably found in the realms of feeding and chilling, which it is proposed in this Paper to compare with older methods.

Orthodox Chilling

Metallic chills have long been used, but the following important points must always be borne in mind:—(1) A rusty chill may cause serious blowing; (2) the chill may be burned on to the casting, and (3) to prevent warming of the chill, the casting must be poured rapidly. Chvorinov[1] has advocated the use of magnesite brick or silicon carbide chills, but these have greatly decreased effects.

Tellurium Chilling

Tellurium was first introduced into this country as a chill-inducer in cast iron, just prior to the war, but was not adopted, and up to now has had sparse treatment both on the foundry floor and in the literature. Tellurium has been applied as a ladle addition, a mould-paint, and mixed in facing-sand, but the paint method is generally considered the best. The difficulty of this method is in its application, for not only does tellurium melt at 452 deg. C. and boil at 1,390 deg. C., hence tending to volatilise, but a plain water-suspension rubs off, and also tellurium settles rapidly from suspension. The following mixes have been suggested:—

Author.	Tellurium, gms.	Plumbago, gms.	Bentonite, gms.	Silica, gms.	Water, litres.	Alcohol, litres.
Sumner[2]	20.0	200.0	—	—	1.0	—
Vadeboncoeur[3] ..	24.5	—	134.0	61.0	1.0	—
Austin[4]	56.8	—	—	227.2	—	1.0

Difficulties with each of these mixes are:—(1) Settling of the tellurium is not obviously apparent; (2) the paint does not show up well on an already blackened core, and (3) the skin on the chilled area of the casting is not good. The mixture used by the Author contains 300 gms. tellurium, 300 gms. ferric oxide, and 50 gms. dextrin per litre of water. This shows up a cherry-red on the painted core, gives a better casting skin, and although it settles fairly readily this is very apparent, and the mixture may be easily stirred. The mix deposits about ¼ gm. tellurium per sq. in., the density of chill being altered by painting either the whole or strips as required.

A comparison of the use of tellurium and metallic chills is shown in Fig. 1, which illustrates a boss (4 in. dia. by 3 in.) from the centre of a plate 18 in. diameter and ¼ in. thick (T.C.,3.2, Si, 2.3, and P 0.9 per cent.). When metallic chills were applied in the positions shaded the result was as shown, whereas a tellurium painted core applied round the circumference of the boss resulted in it being completely solid, other methods being identical in each case. The Brinell values were as follow:—

Position.	Metallic chill.	Tellurium core.
A	115	140
B	190	145
C	130	105
D	150	160
E	170	150

Feeding

Feeding may be divided into two types:—(1) External methods adopted after casting, and (2) feeding which proceeds automatically, due to the moulding methods employed. The first group contains rod feeding, which it is generally agreed by founders should only be used as a last resort, as everyone has at some time or other experienced wasters due to this method. Moreover, in this group comes electric arc feeding, which is—as yet—of little help in the small jobbing shop.

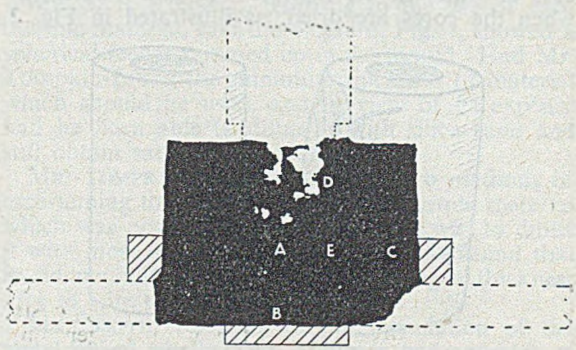


FIG. 1.—*Chilled Boss from the Centre of a Plate 18 in. dia., ¼ in. thick, with Metal Chills applied in the Positions Shaded.*

* The winning entry for a short paper competition organised by the East Midlands branch of the Institute of British Foundrymen.

Chemical Chilling and Feeding

In the second group of feeding methods are found the various designs of feeder-head which have been used:—

(1) The open, cylindrical feeder, which frequently does more harm than good.

(2) The closed cylindrical feeder, which is only partially effective, feeding by ferrostatic pressure only, and not aided by atmospheric pressure.

(3) The "Williams" feeder, which is a blind riser in which is incorporated a vented core so that atmospheric pressure may help to feed the casting.

(4) The spherical feeder, which is similar to the closed cylindrical feeder, but having an increased efficiency due to the heat transfer area per volume of feeder being less.

Each of these methods, and various combinations of them, have from time to time been applied by the Author, but none has given such good results as when exothermic feeding methods were adopted.

Exothermic Feeding

Several proprietary brands of exothermic compound are available, each bearing an essential relation to the "Thermit mixture" reaction:—

$3Fe_3O_4 + 8Al = 4Al_2O_3 + 9Fe + Heat$ (3,300 deg. C.)

It will, however, be remembered that this reaction takes place only above 1,400 deg. C. and so a "detonator" is incorporated in these mixtures. From his experience, the Author considers that the type of mixture mouldable into cores is the easiest and most successful in operation.

The chief difficulty of application of these core feeders is in production of the core, for a slight excess of water in the mixture will give "bursting" when the cores are dried, as illustrated in Fig. 2, and any rise above the stated temperature in the drying process will lead to "firing" of the cores in the stove.

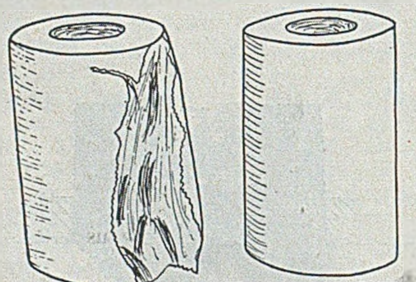
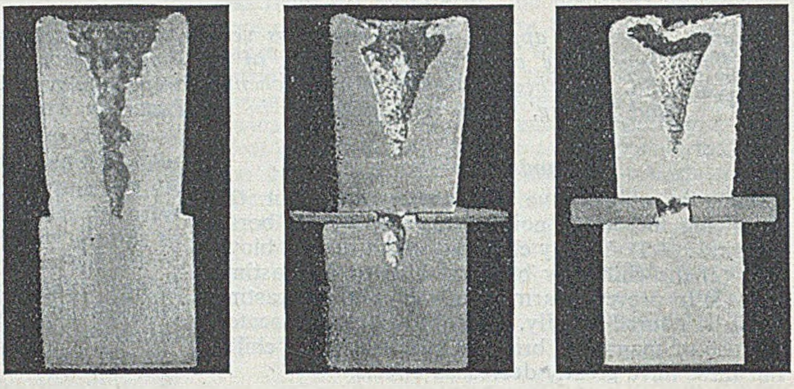


FIG. 2.—*Exothermic Sleeves, the one on the Left having Burst owing to Excess Water in the Mixture.*

These cores may be used as "breaker" cores in the open or closed types of cylindrical feeders, the effect being demonstrated in Fig. 3, where (*a*) shows a cylindrical open feeder piped well into the casting, (*b*) incorporates a silica-sand breaker-core, giving secondary piping, and (*c*) has a breaker-core of exothermic material, the casting being correctly fed and, after cooling, the head being easily broken off.



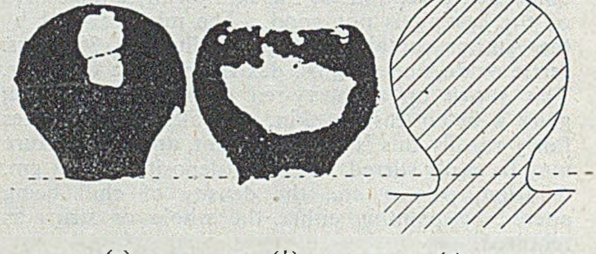
(*a*) (*b*) (*c*)

FIG. 3.—*Use of Exothermic and Silica-sand Breaker Core Feeders. (a) Without Cores; (b) with Sand Core; and (c) with Exothermic Core.*

The Author has found this material most successfully applied in spherical feeder heads. For comparative purposes many of these feeders of a certain size (Fig. 4*c*) were sectioned and their "efficiency" calculated, assuming that a feeder-head with no metal remaining in it would be 100 per cent. efficient. Over the whole range of castings covered, the best result from a silica-sand head was 27 per cent. (Fig. 4*a*), while that from an exothermic sphere reached 44 per cent. (Fig. 4*b*).

Conclusions

In a jobbing shop, where the methods by which wasters may be produced are legion, it is gratifying



(*a*) (*b*) (*c*)

FIG. 4.—*Exothermic and Silica Sand Feeders. (a) Shows the Efficiency when made in Silica Sand—27 per cent.; (b) the Efficiency when made of Exothermic Material—40 per cent.; and (c) the General Design.*

to feel that some light may be cast into the gloom by the chemical methods outlined. By the application of these methods, and other known scientific data, it may be possible within the next few years to reduce the present uncertain methods of feeding and chilling to a state of economical and mathematical precision.

Acknowledgments

The Author wishes to express his sincere thanks to the directors and staff of Rice & Company, for their encouragement and help, to Mr. J. L. Francis, of Foundry Services, Limited, for permission to include Figs. 2 and 3, and to the authors, named and unnamed, to whose work he has referred.

REFERENCES

1 "Control of the Solidification of Castings by Calculation," N. Chvorinov, *Proc. Inst. Brit. Foundrymen*, Vol. XXXII, p. 235.

2 "Initial Results on the Influence of Tellurium as a Chill-inducing Medium in Cast Iron," A. N. Sumner, *Proc. Inst. Brit. Foundrymen*, Vol. XXXIX, p. B106.

3 "Tellurium Corewashers," J. O. Vadeboncoeur, *Trans. Amer. Soc. of Metals*, 1945, p.

4 "Use of Tellurium," C. R. Austin, *Foundry*, Vol. 77, July, 1949, p. 74.

DISCUSSION

Mr. H. P. Millar said the subject of chilling castings by chemical methods was a very intriguing one and Mr. Tompkin should be encouraged in the work he was carrying out. Having tried chilling by using tellurium he found that after a few days' use he rapidly became a social outcast due to the very strong garlic fumes which arose on pouring, and which clung to clothing and lodged in the lungs for quite some time. He would be interested to know if Mr. Tompkin had experienced the same trouble.

Mr. Tompkin admitted that he had noticed these fumes. They were apparent when the tellurium was in a dry state, that is, when making up the suspension or when casting. It had been used for some considerable time now, and no complaints had been received from the foundry on the casting side. The suspension could be made up either in a fume-cupboard or in the open air to obviate the difficulty.

Mr. Butters asked whether tellurium was a medium for chilling or densening, and whether one could induce a white fracture by its use.

Mr. Tompkin said many foundrymen would be glad to know of the exact action of tellurium. A white fracture was being obtained, but the surface effect was not so keen as with a metallic chill, the penetration, however, probably being deeper. The effect was chemical and not physical, due to the probable formation of tellurium carbide.

Mr. Butters asked how one would apply tellurium to promote a white casting from what would normally be a grey casting. Supposing a casting had ½ in. sectional thickness, one treated the face of the mould-core with tellurium to get a white fracture. With a 4-in. thick casting would one only expect to get a densening action.

Mr. Tompkin regretted he had no such experience, but suggested that in the latter case the best method would be a ladle addition.

Mr. J. Hill pointed out that tellurium was used frequently in the cupola black-heart malleable inoculation process to-day.

Mr. Sanders noticed that Mr. Tompkin had made a statement that in his personal view the best way was to cast slowly. How did he eliminate blowholes? Was tellurium expensive?

Mr. Tomkin said he had not had any blowholes at all in castings using tellurium. As far as the economic side was concerned, with a metal chill one had to make a pattern, rough as it might be. Metal chills became lost; they got dirty and rusty, whereas with tellurium there was initially a corebox to be made, but after that the cost was very small. The deposit was about ¼ gm. per sq. in. The present price of tellurium was about 14s. per lb. He had not entered deeply into the economical side, but it would appear that it was as cheap, if not cheaper, than metal chills.

Mr. Lamb asked what was the form of the core, and what was the size of the core related to that of the feeder.

Mr. Tomkin, referring to the third illustration, said that the diameter of the hole in the core varied from 1 to 1½ in., while that of the riser peg was from 1½ to 2¼ in. The thickness varied from ⅜ to ½ in.

A member asked whether it was advisable to spray the tellurium on the mould surface.

Mr. Tompkin said he had only applied it to the mould where dried moulds had been used. He had not actually sprayed them, but saw no reason against it. Economically it was not so good, owing to the larger amount of tellurium which would be used. He had used the mixture painted on dry sand.

Mr. Millar, speaking from a chill formation angle, asked whether it was satisfactory to impregnate the mould surface. The material could either be painted on or dusted. In this connection, he had particularly in mind a cam type of casting which might require the working surface chilled, and yet at the same time leave the centre of boss portion freely machinable for boring or slotting.

A member asked what the effect was on the machinability of the casting.

Mr. Tompkin, in reply, said that he admitted that in the very early stages before the volatility was fully realised there were quite a few castings returned where the tellurium had affected the portion which had not been required chilled. This had been overcome by running in such a way that the metal came up to the tellurium, and since then there had been no trouble.

Mr. S. P. Russell, referring to the use of exothermic material, said the diagram, Fig. 4, showed a spherical feeder rammed up in the mould. Had Mr. Tompkin found the minimum thickness of material which should be used, and in view of its expense had he been able to dilute it with silica sand and still obtain satisfactory results?

Mr. Tompkin said he had tried two methods of ascertaining the amount of this exothermic material which was now being used. The first was to dilute it with more sand, in which case it was found that it did not answer. He was now using a thickness of ¼ to ½ in. undiluted.

Mr. Smith, referring to the inoculation of the metal, asked whether Mr. Tompkin had any idea of the accumulative effect over a considerable period.

(*Continued on page* 16)

Valve Tappet Castings*

Discussion of Mr. R. Dulché's Paper

The Author of the Paper, "Value Tappet Castings," who is a French member of the Institute of British Foundrymen (attached to the London branch), was unable at the last minute to present the Paper personally owing to unexpectedly prolonged business in French North Africa. At short notice, Mr. E. Harwood Brown, himself well conversant with the tappet foundry, deputised for Mr. Dulché, not only in the reading of the Paper but also in the ensuing discussion, of which what follows is a report:—

MR. G. C. PIERCE asked what was the percentage of defective castings experienced in the production discussed in the Paper. By "defective" castings he meant those returned from the machine-shop by reason of air holes, etc.

MR. HARWOOD BROWN replied that the foundry was actually independent of the automobile industry, and he believed that industry would not accept supplies which involved a bigger proportion of rejects than 5 per cent. Every endeavour was made by the foundry to limit scrap, and to the best of his knowledge the number of defective castings delivered to the automobile industry, after rough machining, was less than 5 per cent.

MR. WATSON asked whether the chill plates were dressed with plumbago, or oil, or anything else.

MR. HARWOOD BROWN said there was no dressing whatever.

British Experience

MR. P. D. PINCOTT confirmed the point made in the Paper that extreme care and control in the production of chill-cast tappets was essential. The company with which he was associated had made many thousands of chill-cast tappets for high-speed oil engines about two years ago. There were about four different types of tappets used in the oil-engine industry; some resembled poppet valves with a head of probably 1 in. dia., the stem of the rough casting being approximately ¾ in. dia. and 2 to 2½ in. long and others with stems 5 in. long.

Realising that the tappets would be required in large quantities—of the order of 100,000—it was considered that the job was quite a good one for machine moulding, if the process could be sufficiently controlled. They began to make the tappets in quantities of something like 30 in a 16 in. by 20 in. box, by a method used in the Midlands, but after about a thousand were made there was a fair percentage of rejects from the customers, the trouble being the presence of blowholes in the stems. By increasing the permeability of the sand, quite a number of the blowholes were eliminated, but some still persisted, so that it was necessary to resort to other methods. Curiously enough, completely confounding foundry practice, it was found that the best results were obtained by inverting the whole job with the chill plate on the top. Very many thousands of tappets were made by that method with reasonable success. Very great care was necessary, both from the sand point of view and also metallurgically. So far as he was aware, Mr. Pincott concluded, there were only two foundries in this country producing chill-cast tappets for the high-speed oil-engine industry at the moment, and if there were other founders who considered they had the knowledge, the technical control and the ambition to produce tappet castings, there was probably a good field for them.

MR. G. C. PIERCE said he was extremely surprised to hear, in reply to his earlier question, that the percentage of wastage was as low as 5 per cent. Stating that he was not a chill-cast tappet expert, for he had never made one in his life, he said that on listening to the Paper he had been rather confused with regard to the chill plate. He understood there were three grooves in the plate; the metal came in from the top, and the castings had two stems. The runner had to take the metal down to 14 separate compartments. He was loath to believe that the metal entered all those compartments at the same moment; indeed, he was certain that it would enter one compartment before another. At the far end, when the metal dropped into the mould, he had in mind that it passed a core and touched on to a chill plate, giving rise to some air accumulation, which air was supposed to get away along the grooves. He visualised that some of the air was driven backwards as well as forwards; in going backwards it would take the line of least resistance and would move up towards the next compartment, meeting some of the metal coming down. If that were so, he would expect a greater number of rejects than 5 per cent., and the rejections would be met with, particularly on the grinding operation. Another matter which had astonished him was that metal was melted in a cupolette at the rate of 1 ton per hour.

MR. HARWOOD BROWN said it was a small cupola, but was of full height; it was not the conventional type which normally had a height of about 6 ft.

Pouring Method

MR. PIERCE suggested it might be called a cupola. The metal was tapped into a 6 cwt. ladle and was taken from there in hand ladles containing approximately 100 lb. of metal. He would have thought that by the time the twelve moulds were poured, the metal at the bottom of the 6 cwt. ladle would be far too dull to be used to pour castings of that kind. He was surprised that that could be done, especially when using only a small cupola and burning very indifferent coke, although he noted that the ratio was about 7/1.

MR. HARWOOD BROWN said he had pointed out, and he thought he had stressed the point, that the cupola taphole was left open the whole time and the

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* Paper presented to the London branch of the Institute of British Foundrymen and printed in the June 7 issue of the JOURNAL.

Valve Tappet Castings—Discussion

metal was running continuously into the ladle, which latter was used solely as a receiver. Hot metal was trickling into the ladle continuously as the ladle was tilted. In effect it was a tilting receiver.

MR. H. O. SLATER commented that the cupola used was virtually a continuous-melting furnace; the metal was running almost at the rate of its melting.

Possibility of Die-casting

MR. B. LEVY, having inspected a specimen of the casting, said it seemed the sort of job which could be die cast by some of the modern methods of which there had been so much talk recently. He wondered whether others felt the same way.

MR. HARWOOD BROWN could not see how that could be done. If they were to use a chill round the whole job, how could they get one portion soft and harden the other face?

MR. LEVY suggested it would only be a matter of a suitable cycle on a rotary machine where the chill plate which it was desired to keep cold was automatically changed as the cycle came round.

MR. HARWOOD BROWN said that when casting cast iron in cast-iron chills, one used essentially a high-silicon iron, which would not easily take the chill. In the case under discussion one definitely wanted a chill hard surface on one side and not on the other, and he did not think the necessary temperature difference could be maintained. It might be possible, but he could not visualise it easily; it would call for an enormous amount of setting up.

MR. W. WILSON drew attention to the Holley die casting method which was brought to this country by a very large motor-car manufacturer who ran chill irons into a die and made tappets in that way for many years.

MR. HARWOOD BROWN asked if Mr. Wilson considered that that was really a chill casting machine. He believed the actual casting in that case was made in a separate core and was chilled only on one face.

MR. WILSON said there was a metal die; and the casting was known as a push rod. Further to the above, in explanation, the castings were in some cases hollow so that the outer face was chilled all over, but the internal hollow was formed from a sand core.

Lack of Chill Dressing

MR. A. R. PARKES expressed surprise that no dressing was applied to the chill, and that even though the moulds stood sometimes for hours, there was no condensation from the green-sand portion of the mould. He asked if Mr. Brown could explain that.

MR. HARWOOD BROWN said there was not sufficient moisture to cause trouble. A very porous sand having very even grain size was used; it had rather amazing porosity for a sand of that skin, and no difficulty arose in the manner suggested.

MR. P. D. PINCOTT said in his experience of the work, to which he had referred earlier, no dressing was required on the chill plate; and oddly enough, although the chill was in contact with the sand for probably a few hours, no trouble was experienced with the chilled face of the tappet itself from moisture condensation. The troubles they did experience were due purely to small gas holes on the stem.

Chill Control

MR. F. P. ROBINSON asked whether the cupola charges were subject to laboratory control. It had been stated that the first charge of approximately 2 cwt. was invariably pigged. If the charges were not subject to metallurgical control, what made up the difference in the silicon and manganese losses?

MR. HARWOOD BROWN said he had tried to make it clear that the Author had stressed the necessity for very strict control of the metal by analysis. On each individual charge it was not normally possible with cast iron to get a rapid analysis; but at the foundry in France they actually cast small test-pieces. In that particular foundry they made a rather different type of tappet (of which he produced a sample), which was itself used as a control piece. They cast it with the heavy side on the chill face, and afterwards they split it by means of a hammer, so that they had a visual record of the actual chill.

A MEMBER, reverting to Mr. Levy's query about making the tappets in a very modern type of die-casting machine, said he was not qualified to give a definite answer, but he rather suspected that in addition to having to place a sand core for a hole, it would also be necessary to have a core for the outside diameter. He believed that in that particular application the tappet must have only a chill face on the one top face.

MR. HARWOOD BROWN said that was correct.

THE MEMBER said it meant that a 2-core plate was used for each casting, and that would be very much against the required production rate from an up-to-date die-casting machine. So that perhaps die-casting methods could not very well be applied to the production of those particular tappets, because of the number of cores which would have to be placed in each die.

MR. LEVY held that it would not be necessary to have two cores, because the central core and the external core could easily be incorporated in one.

THE SPEAKER suggested that very expert core making would be required, but MR. LEVY thought it would be quite simple.

Vote of Thanks

MR. PIERCE said it was a privilege to propose a vote of thanks to Mr. Dulché and to Mr. Harwood Brown. The meeting was particularly grateful to Mr. Harwood Brown, he said, because he had recently been in hospital and was still surrounded with plaster, so that he had been speaking under great disability. Nevertheless, he had presented the Paper in an exceedingly able manner. He had studied carefully the process described and had helped to compile the Paper, and had arranged for the diagrams and the lantern slides. It was a great pleasure to propose a very hearty vote of thanks to both gentlemen.

MR. V. DELPORT, who seconded, entirely concurred in all that Mr. Pierce had said of Mr.

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Harwood Brown. One did not know under what sort of physical pain he had presented the Paper, but he was deserving of the very best thanks for the great effort he had made. It was always difficult to present a Paper on behalf of an Author who was not able to be present and there was difficulty in answering questions raised in the discussion.

The members of the branch were also anxious that their thanks should be conveyed to Mr. Dulché, for the Paper gave a complete description of a tricky business, a very specialised production; from the discussion one learned that even those who had not specialised in that type of production had found in the Paper some points of great interest.

(The vote of thanks was accorded with acclamation.)

MR. HARWOOD BROWN expressed his appreciation. Mr. Dulché, he said, had gone a very long way to give an appreciation of what was being done at the foundry, and such interchange of knowledge would do something to ensure an even greater friendship between the two countries. For himself, Mr. Harwood Brown said it had given him very great pleasure to help. Mr. Dulché had started to write the Paper in English, but he had found it was taking up a great deal of time; Mr. Harwood Brown added that he had volunteered to re-write it from the French, but he had not bargained at that time on having to present the Paper, for until almost the last minute, Mr. Dulché had expected to be present.

For the benefit of any who might contemplate taking up such production as had been described, Mr. Harwood Brown said that Mr. Dulché's foundry had been previously a small jobbing foundry until the task of producing a large quantity of tappets was offered; there had been no specialised equipment at all at that time and they had immediately got down to the job of developing what was required for that specific purpose.

Chemical Chilling and Feeding—Discussion

(*Continued from page* 13)

MR. TOMPKIN replied that because it had not been going on long enough he was unable to give any information.

MR. C. PAYNE thought he might enlarge just a little on that point. If one assumed it was the same chemical family as sulphur, the melting point of sulphur was below that of cast iron, but one could pick up sulphur in the cupola. If one had tellurium in the metal, was it going to be lost in the cupola or would there be a tendency gradually to build up? From what had been said, it was not only in the same family, but more potent, in so far as it was understood that about 0.02 per cent. would give a white iron. He asked if Mr. Tompkin could make any further comment on that.

MR. TOMPKIN replied that, although of the same chemical family as sulphur, the action of tellurium on cast iron was believed to be entirely different, in that tellurium carbide and not iron telluride was formed. Thus he felt that build-up was unlikely, but this was a matter which only time would prove.

Changes in Publicly-owned Companies

The Iron and Steel Corporation of Great Britain announces the following changes in the boards of three publicly-owned companies:—

KETTERING IRON & COAL COMPANY, LIMITED—Mr. F. Scopes has been appointed a director and chairman in succession to Mr. James Gough, who recently resigned.

NEW CRANSLEY IRON & STEEL COMPANY, LIMITED—Mr. H. J. Ellison, chairman and managing director, has retired. Mr. F. Scopes has been appointed chairman and Mr. G. H. Johnson managing director.

Mr. Scopes is managing director of the Stanton Ironworks Company, Limited. His appointment to the chairmanship of the Kettering and New Cransley companies does not imply any connection between these companies and the Stanton company.

Mr. G. H. Johnson is managing director of the Kettering Iron & Coal Company.

GLYNHIR TIN PLATE COMPANY, LIMITED—Mr. Edward Withington and Mr. N. W. Fischer have retired from the board. Mr. W. S. G. Rees has been appointed chairman and Mr. O. J. Thomas, Mr. Ivor Lewis, and Mr. E. Arthur Withington have been appointed directors.

Coltness Iron's New Scheme

The board of the Coltness Iron Company, Limited, has been advised that the necessary liquidation formalities may be completed in time to submit such resolutions to shareholders around September 30. This announcement was made by Lt.-Col. J. F. H. Houldsworth, chairman, at the extra-ordinary meeting held on June 22 in Glasgow, when the withdrawal of the July, 1950, scheme of arrangement and reduction of capital were unanimously approved.

This withdrawal followed the refusal of the court to sanction the scheme on the ground that one of the requirements of the Companies Act, 1948, had not been complied with.

At an extra-ordinary meeting the chairman said that it is desirable that the formation of the new company to take over the operating assets should coincide with the date of liquidation of the present company.

Cargo Fleet Extensions

Early next year the Cargo Fleet Iron Company, Limited, hopes to complete the building of one of the biggest blast furnaces on Tees-side, a new steel furnace, and a battery of coke ovens. Disclosing these facts at a works presentation, Mr. G. Barry Thomas, a director and general works manager, said that the capacity of the blast furnace would be more than 4,000 tons a week and the steel furnace would have an output of 2,000 tons.

Mr. Thomas added: "Although we have had a successful year, we have recently felt the draught a little through circumstances which are absolutely out of our control. The shortage of scrap and of ore-carrying ships has resulted in some reduction of the company's ingot output."

IN ORDER to save shipping space, John Baker & Bessemer, Limited, Rotherham, have started shipping machined wheels and axles separately for assembly at overseas destinations. This has been made possible by improved methods of machining components in the company's new machine shop. It is the first time in the history of the wheel and axle trade that this has been done and the space saving is considerable.

Design for Vitreous Enamelling

Report of a Symposium held at the Spring Meeting of the Institute of Vitreous Enamellers at Bournemouth, 1951. Most of the features are applicable to ironfoundry productions, and as many foundry enamellers are also enamellers of sheet steel the section dealing with this material has been included.

I—STYLING OF ENAMELLED PRODUCTS

By A. B. Kirkbride, B.A.

The task of defining the value to the manufacturer of styling a product is evidently thought to be a controversial question, and it is certainly of great importance, but it is proposed to deal with it rather briefly before passing on to subjects of more particular interest.

First of all, two lines of approach immediately present themselves, namely, the general beneficial effect to a manufacturer that a product may or may not have when it arrives on its market, or in other words, how well it sells; and, secondly, the advantage to the manufacturer of employing the team of people who are most likely to achieve first-class results when developing a product. If it is agreed that a product is only as good as the results of the team which develops and makes it, and that the results of a team are greater than the sum of its component members, the importance to the manufacturer of picking the right team to design and make his products will be realised.

Dealing with the first approach, one might say that the value of styling a product resolves itself, in the majority of cases, into the economic value of employing someone to look after and try to improve the appearance and functions of the products; and in the last analysis into the question of whether one is likely to sell more articles or sell the same number of articles more easily if their appearance is more pleasing than that of their competitors or predecessors.

The answer to this is surely that one is bound to be more likely to do so and any attempt to expand the subject would result in the most blatant glimpses of the obvious.

Choosing a Team

It is much more important to consider what sort of a team is most likely to produce a best seller than to continue talking rather vaguely about how any particular article might sell. It may prove informative to outline, therefore, the probable set-up of a team and the contributions they are able to make from their knowledge and experience.

First there is somebody on the sales side, either a sales director or the sales manager who determines: —How much the article should cost; what is the market; how many he estimates can be sold; how the product is distributed; what are desirable merchandising features; what competition there is, etc. Next on the list is the development engineer or research manager who determines:—About the technical design and function of the product; engineering practices; British Standard specifications; availability of materials and, of course, performance, etc. Then comes the production engineer, who knows about:—The limitations of materials; tooling; the ease of assembly; the limitations of finishes, and other production methods. Missing from this material from the product point of view is the chairman's approval on policy, somebody to advertise its good points, someone to patent those points and someone to do the creative thinking on its appearance.

The last member of the team, the industrial design organisation, will contribute:—A knowledge of appearance values and of the development of style, and a trained imagination on function and merchandising and experience in the assessment of the factors influencing the design brief. Hence the design organisation's contribution appears to be somewhat more vague than that of the other members. Designing, like vitreous enamelling, is not an exact science. What can be said of both their results is that it is a lot easier to judge and criticise them when they are finished than to achieve them in the first place.

Co-operation

In order to develop the design organisation's contribution it is helpful to consider a hypothetical case history on the design of a product. Naturally the case history and the thoughts about to be described are purely arbitrary and bear no relation to any particular product, and also it must be remembered that an actual case of this type would probably take at least two months to get to the model or prototype stage and that a great deal more work and thought is involved than the impression given by this quick outline. The aim is to make clear the sort of thinking and work which a design organisation does when working out a particular problem.

Suppose therefore that a team of industrial designers has been retained to design a product such as an electric iron. The electric iron has been chosen as an example because the Author has never had anything to do with the design of one, and on the presumption that many people will therefore start from the same point.

In the first place it quite certainly is not going to be an easy job; after all ever since the iron was invented a succession of extremely intelligent people have expended a vast amount of energy and thought in trying to improve and better the iron in every possible way.

Try to imagine what the client expects of the team; he has taken a gamble on it to produce for him a design which will constitute a real step forward in the marketing of irons, he is trusting to its experience as designers to give him a handsome iron,

Design for Vitreous Enamelling

to its knowledge of marketing to give him something which will outcall all his competitors and to its intelligence to design it within the limitations set by his engineers. This is not a matter for a sketch pad and pencil effort in five minutes, there must be a methodically compiled and comprehensive brief before considering putting pencil to paper. This may be called the designer's brief to avoid confusion with the client's brief. The designer's brief is compiled in an endeavour to establish all the facts, data, thoughts and ideas that have a bearing on the subject or influence the design. One of its functions is to provide a safeguard against a form of loose thinking which tends to arise when more or less abstract subjects are being considered, namely, the tendency so often found amongst designers to think that because they did it the design must be good. This leads of course to submitting to the client, with a proud smile, the first possible solution that comes to hand.

The following is a very incomplete example of a designer's brief, about sixty or seventy per cent. of which is provided by the client either directly or indirectly:

1. *Client's Marketing Brief*, in which he states how many irons he wants to sell, where, when and at what price, etc.
2. *Client's Engineering Brief*, which tells what an iron is and why—how it works, how it is made and from which materials.
3. *Research on Competitive Products*, which covers, amongst other things, the fact that someone has patented the idea of spraying water from the front of their iron and that sort of thing.
4. *Research on non-competitive Products*, which consists of finding out about foreign products not sold on the same market—if any, and also includes gas, paraffin and charcoal irons.
5. *Sale Research*, whereby for instance it is revealed by going to departmental stores, that people are suspicious of things they do not understand, and therefore the iron must look extremely well made and easy to use.
6. *Practical Research*, whereby the fact is recognized that it cannot be seriously expected that the design which is put into the hands of thousands of women will be of the first order if the team have never handled an iron,

and so on. The more knowledge the design team can accumulate the better—it will help in the second part of the brief which consists of ideas. Note the categories and the order in which they would be considered.

1. Functional Ideas. For example, to make the iron pointed at both ends.
2. Merchandising Ideas. These are by definition not essential to the main function of irons and are by way of being gadgets such as the light which operates in conjunction with the thermostat.
3. Ideas on Appearance. Perhaps the use of a vitreous-enamelled finish for the upper body.

Incidentally, these are not original ideas and can be seen on irons at present in the shops.

When the brief is as complete as it can reasonably be made or in other words when the design organisation is in a position whereby they have the greatest possible chance of giving the client a thoroughly digested design, the design of the iron can be started. The final design must correlate all the items in the brief into a single solution. If the design is right all these items will fall into place in the most satisfying way and the designers will get the tremendous feeling of a job well done, but if things do not fall into place they must go back and recheck all their thinking until they find out where they went off the track. Their job is not to alter the existing model just for the sake of it—they have got to give their client a product that will put him right on top of his competitors.

Conclusion

The foregoing has tried to show how a development teams works in its simplest form and to give a very vague idea of how the industrial design part of it works. Can a manufacturer afford to drop out of his team a quarter of its input? As pointed out above, it will mean more than a quarter off its output.

It must however be pointed out in conclusion, that the market conditions that hold sway to-day are a source of depression to both manufacturers and designers. On the other hand, those who see something stimulating about a period of renewed shortages are not necessarily crazy, for if a shortage becomes sufficiently drastic something is done about it.

Up to now confidence has existed that the war-imposed scarcities would one day disappear and it is the new necessity to earmark raw materials for armaments that is causing confidence to ebb. But it is always darkest just before the dawn, and the present may ultimately prove to have been a pre-dawn period. Shortages breed substitutes, and necessity is the mother of invention. The materials for making all sorts of metal appliances are short, and civilisation has decided that a great many of them are necessities. As a result, inventive minds are likely to turn to this subject, and the situation may lead to ingenuities in design as yet undreamed of. Therefore, far from regarding the present outlook as being one of unrelieved gloom, we can look forward to a re-birth of inventive and stimulating features in the design and manufacture of the types of appliances with which we are all concerned.

II—PRODUCTION OF CASTINGS FOR SUBSEQUENT VITREOUS ENAMELLING

By Wm. Todd

It has been said that foundrymen do not know what the enameller requires. No specifications exist, or, if they do, at any rate they are not quoted. Strangely enough, enamellers have been telling the industry as a whole, and the foundry in particular, what their requirements are and what to avoid, for the past 25 years at any rate—in fact, ever since the introduction of the application of vitreous enamel to cast iron by the wet process.

In 1935, one of the past-presidents of the Institute, Mr. J. W. Gardom, gave a Paper on "Cast Iron for Vitreous Enamelling." Therein he stressed the importance of design, melting practice and sand control. He indicated the lack of agreement on composition and structure of material; he also discussed the causes and prevention of blistering. It is to be hoped that, as he is one of the sponsors of the new committee that has been set up to investigate cast iron for enamelling, it will at any rate be possible to establish some agreement in regard to these two important problems, *i.e.*, composition and structure.

A recent chairman of council, Mr. C. P. Stone, gave in 1936 a Paper entitled "Common Defects in the Vitreous Enamelling of Cast Iron, etc." He asked, like many others, for close co-operation between the enameller and the foundryman, and he enumerated various "Dont's."

Under the auspices of the Institute, Papers on cast iron for enamelling have appeared with unfailing regularity from 1936 to 1942, inclusive. Admittedly, the submissions and conclusions are sometimes controversial, but they do provide ground for the ultimate establishment of standard practice. Again, during the years 1936, 1937 and 1938, two voluminous bibliographical works appeared, sponsored by the joint committee of the I.V.E. and the B.C.I.R.A., of which body the Author had the honour to be chairman. This volume contained over 30 direct references to the problems attendant upon the application of vitreous enamel to cast iron and ranged from foundry technique and melting practice to the pros and cons of facing sands; in fact, there is hardly any phase of the problem that has not been touched upon during these years.

Also, in recent years the Association of Vitreous Enamellers introduced their brochure entitled "Design for Vitreous Enamelling." Their bibliography included American references to cast iron for enamelling dated as far back as 1930. One especially worthy of mention is entitled "Give the Foundry Practice the Attention It Deserves"—a praiseworthy sentiment.

In their compilation the V.E.A. stressed the importance of providing soft grey iron, and a casting of uniform section, and of avoiding the risk of drawn or porous areas at the junction of thin and thick sections. They urged that the components should be cast with the surface to be enamelled face downwards in the mould, it being desirable that, if there have to be surface imperfections, they should be on the back of the casting. They also pictorially illustrate suggestions to the designer as to what to avoid and the alternatives to adopt in the interest of production of castings suitable for vitreous enamelling.

Speaking in the rôle of the foundryman, it is possible to give the designer and the enameller some assurance that castings can be supplied to design and specification as set out by them, and subject to such essential modifications as have been asked for and to which their assent has been obtained. In other words, there is an understanding of each other's problem and mutual agreement has been reached.

Specification

Enamellers require that castings supplied for enamelling should be of uniform thickness and free from sudden changes in section, thus avoiding unequal strains. The castings should also be free from sand holes, slag inclusions, pinholes, surface defects and those below the surface which are only revealed by subsequent shot-blasting.

It is appreciated that the enameller does not require the smooth finished surface so desired 30 years ago by finishing departments. The need then for such a surface was to reduce the amount of time spent on grinding and polishing in order to prepare the castings for ultimate nickel plating and/or stove enamelling. It is also appreciated that an orange-peel-like effect, free from surface defects such as "rat-tails" and burnt-in sand is desirable. Sharp corners should also be avoided, and radii and rounded edges introduced wherever possible. All bosses should be reduced or lightened to a minimum diameter consistent with strength, or alternatively cored-out bosses used. Sufficient taper or draw should be allowed to assist moulding operations, and heavy ribbed sections avoided, as these invariably mean abrupt changes of sections. The required strength can be ensured by other means, such as corrugating.

Also, by collaboration with designers, as far as practicable, an equal expansion throughout the area of the casting should be aimed at, so that the absorption of heat is in proportion to the varying metal thicknesses of the casting. Structure should be fine-grained. Metallurgists advise that the structure should be for preference pearlitic with slight ferrite formation but no free iron carbide. The structure should not become cementite or chill, because then one would expect to get warpage and/or shrinkage. A typical composition is shown in Table I.

TABLE I.—*Recommended Composition of Cast Iron for Enamelling.*

—	Metal composition, per cent.	
Element :	Min.	Max.
Silicon	2.2	2.5*
Manganese	0.5	0.7
Sulphur	0.08	0.11†
Phosphorus	0.06	0.9
Total carbon	3.2	3.5
Combined carbon	0.01	0.3

Pouring temperature : 1,380 to 1,400 deg. C.

* Above this limit is a tendercy to coarse separation of graphite. Below the minimum mottling would occur and create difficulty in enamelling.

† Quantitatively combined with Manganese.

Foundry Technique

One appreciates the problem set to jobbing foundries who may make anything ranging from manhole covers to high-grade castings for coal, gas and electrical domestic appliances. Having determined the required composition, it should be possible to maintain it by efficient and adequate technical and supervisory control of melting, sand preparation, moulding, facing, gating, running and pouring temperature, thus ensuring as far as possible the

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economic production of sound castings free from trouble-making variables.

In conclusion, it may be said that while the production of castings to the standard indicated would possibly involve an increase in cost, it would obviously be worthwhile because of the ultimate saving which would be effected in the enamelling departments. These comments represent no original contribution to the problem of producing good castings for vitreous enamelling: all that has been said has been said previously on many occasions, but this may have the effect of focussing attention to a problem which can be solved, and it is to be hoped that the new committee set up to investigate cast iron for enamelling will be successful in establishing a new standard or code of practice.

III—DESIGN AND PRODUCTION OF SHEET-METAL PARTS

By C. S. Beers

Vitreous enamel has many inherent and exclusive qualities, and is a reliable and desirable finish for a great variety of products, wherever durability, lasting beauty and cleanliness are desired. To make full use of these fine qualities, it is important that certain principles of design and fabrication are followed. It is not intended in this Paper to make reference to design points where sheet metal is flanged either by forming or bending, or to attempt to deal with recommendations on radii, size of flange, or thickness of metal to use in relation to flat work. While these points are most important and should have serious consideration during the design layout of such parts, they are adequately dealt with in the various text-books available.

A designer's first consideration should be given to the durability and service of the finished product when in general use. It is well known throughout the enamelling trade that sheet-metal parts having small radii, sharp corners and loose metal, will cause untold trouble and expense during enamel processing, and should these parts be allowed to reach the open market, even when they are successfully covered with enamel, trouble will occur in service through chipping, etc., resulting in dissatisfied customers and establishing a "black mark" against vitreous-enamelled ware in general.

The second important point is that the design of article must have sufficient rigidity and stability when finished to withstand the hazards of transportation and handling, without damage occurring through flexing or distortion.

The third, and by no means least, important point is to design the article for sound economical fabrication in such a manner that, when ready for enamelling, it is free from strains and strong enough to resist sagging and warping during the enamelling operation. When this is not accomplished, distortion of the part occurs during firing, and hairlining, warping and chipping result.

Sound design is usually accomplished by free discussion and close co-operation of departments concerned with the production and sale of any article. At this early stage of the proceedings, it is advisable to discuss the project with the steelmaker. The importance of a good sheet-metal base in the production of high-quality vitreous-enamelled products cannot be emphasised too strongly. It is recommended, therefore, that the steelmaker be given full details of the project, when he in turn will advise on the correct grade of steel sheet to be used. Owing to the present shortage of steel sheets, especially the higher grades, consideration may be given to using a lower grade of steel. It is strongly recommended, however, that experiments of this nature should only be tried out on articles which have been successfully produced and vitreous enamelled when made from correct quality steel sheet.

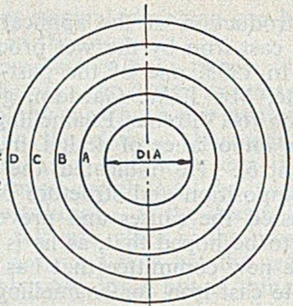

FIG. 1.—*Method of showing Flow of Metal in Drawing by the Use of Concentric Lines on the Blank.*

Drawn Pressings for Vitreous Enamelling

Parts to be finished in vitreous enamel which are designed for production to be completed within the press shop, eliminating all other forms of fabrication such as welding, etc., are usually assured a trouble-free progress through the vitreous-enamel process, provided that the pressings are not over-stressed and no undue change of metal thickness has taken place. The control of these points calls for good tooling design to ensure an even flow of metal during the pressing operations.

As an aid to the adoption of proper tooling design for the production of drawn pressings for subsequent vitreous enamelling, it is interesting to attempt to analyse to some extent the stresses involved in a drawing operation, and to determine the flow of the metal.

The flow of metal can be shown by marking a circular blank as in Fig. 1, to be used for the production of a simple cylindrical drawn cup. The width of each annulet is equal, but it is clear that

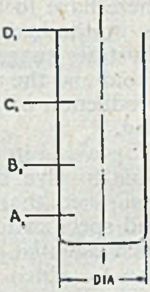

FIG. 2.—*Cup Produced from the Blank prepared as shown in Fig. 1.*

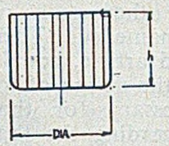

FIG. 3.—*Body of a Cylindrical Drawn Cup.*

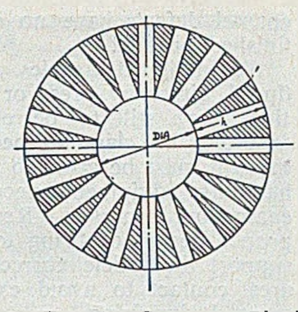

FIG. 4.—*Cut-away Blank for Producing the Cup shown in Fig. 3.*

the area of the annular space at " D " is greater than the inside space " C," and so on. The difference in area must produce a correspondingly greater height for each annulet in the finished pressing, provided the metal thickness is properly controlled during the drawing operation. Hence, " D1 " is proportionately greater than " C1," as shown in Fig. 2. The metal consumed in the body of a cylindrical drawn cup as shown in Fig. 3 should, therefore, be equal to the area of the cut-away blank shown in Fig. 4. Special points of interest arise when considering the drawing of a rectangular shell. In the first place, it will be seen that at the four corners, Fig. 5, a pure drawing process is in action (involving radial and longitudinal, tensile and compressive stresses), whereas at the sides, bending only is taking place (tensile and compressive stresses). From the preceding figures, it will be clear that the amount of metal required to draw up to the height of the box at the corners, will be less than the amount required merely to bend up at the sides.

The above remarks are intended to lay emphasis on the need for very careful designing of tools necessary for the production of drawn pressings for subsequent vitreous enamelling. It is advisable, therefore, that a tool designer should have a sound knowledge of vitreous-enamelling practice, apart from his pressing and tooling knowledge.

The primary causes of warping and hairlining of drawn pressings when subjected to high firing temperatures are: variation of metal thickness, loose metal, work-hardened and over-stressed sections of the pressing. Loose metal will naturally grow and warp in the firing operations, but this can be overcome in many cases by careful blank development and sufficient hold-down pressure being applied through the press to the blank holder, to prevent puckering of the draw flange, and so control the flow of metal into the die. For the drawing of unbalanced shapes requiring differential pressures, special drawing beads may be incorporated in the pressure plates to assist in controlling the flow of metal. During tool try-outs, it is good practice to have a pressing from each stage of production put through to vitreous-enamel finish; valuable information can be obtained from these and very often tools can be modified, or inter-stage anneal be introduced to relieve over-stressed metal, and so eliminate faulty finished ware at a later and more costly stage of production.

Welding

When welding has to be used in fabrication for vitreous enamelling, either through lack of press plant, or the particular shape of the parts, the designer should give considerable attention to the best type of weld to adopt, and the best position for the joint in relation to the shape of the part.

Fettling of welded joints to give a suitable finish for vitreous enamelling can be a very expensive process. Therefore, the position of the weld is important to allow free access for dressing off, to give a perfectly pit-free smooth finish. For this reason, right-angular butt joints should be avoided as the inside of the angle joint cannot be properly dressed, whereas a joint made in the centre of a corner having a suitable radius can be dressed off with ease.

Types of welding in general used for the fabrication of parts for vitreous enamelling are as follows: oxy-gas, carbon-arc, argon-arc, metallic-arc, spot. seam and flash welding. In this respect, the designer has a very wide field from which to make his choice.

It can be said that all the above types of welding will successfully vitreous enamel, provided the welding operation is carried out in strict conformity with the procedure laid down for each particular type. The finished weld must be free from porosity and have good even penetration to allow for dressing off to parent metal thickness, so leaving a clean smooth finish. Should the type of welding adopted call for the use of a filler rod or electrode, it is most important that these should consist of a material having the same specification as the metal to be welded. The inclusion of dissimilar metal in a welded joint will cause endless trouble to the enameller.

A designer's choice should be to adopt a weld that can be mechanically applied wherever possible. Welding that depends upon the skill of the operator, will result in a variety of finishes from a variety of operators. It is, therefore, difficult to achieve a definite standard, whereas welding that can be applied mechanically gives a constant result and thereby enables a definite standard to be achieved.

From experience in the use of all of the types of welding mentioned, it has been proved that flash welding, wherever it can be applied will give the best results for good quality vitreous enamelling.

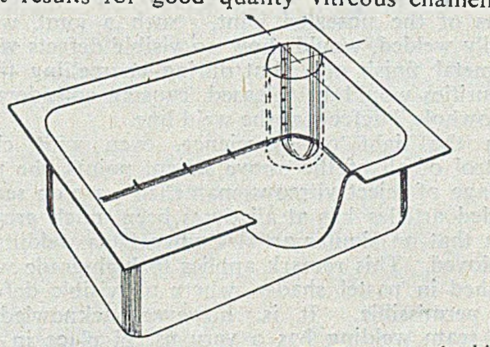

FIG. 5.—*Rectangular Shell in the Drawing of which Complicated Stresses are Induced.*

Design for Vitreous Enamelling

The reason for this is that during the actual welding cycle, the edges of the sheet steel reach fluidity, burning away any exterior impurities simultaneously with the mechanical upsetting motion, forging the edges together, which results in a perfectly clean and homogeneous butt joining of parent metal only. The rapid generation of heat, confined to a limited area of metal by water-cooled electrodes acting as holding clamps on the metal sheets, together with the short duration of the welding cycle, materially assists in the elimination of distortion. This type of weld can be dressed off to leave a finished joint having the same thickness throughout as the parent metal, and when finished in this way, the joint is sufficiently ductile to accept further presswork operation, if required.

From the above notes, it is clear that flash-butt welding gives a perfectly clean joint, free from impurities and distortion, thereby presenting a weld that will be free from at least two problems frequently encountered in the enamelling process.

Seam welding, though mechanically produced, calls for a skilled operator to control the movement of the parts while the joint is fed through the rolls or electrodes of the welding machine. When a seam-welded joint is to be finished in vitreous enamel, extreme care must be exercised to ensure a constant overlap of the two metal sheets. This overlap should not at any point vary or exceed the thickness of the metal sheets used, *i.e.*, when using 16-s.w.g. sheets, the overlap of the seam should be controlled at 0.064 in. during the initial tack welding of the joint prior to the actual seam-welding operation. The reason for the very close control of the overlap joint, is to ensure controlled heat flow for the complete mashing down of the two metal surfaces during the welding process, to give a finished joint of approximately parent metal thickness throughout.

Careful preparation of the overlap surface of the sheets is necessary before tack welding together. These surfaces must be perfectly cleaned and all traces of scale and foreign matter removed. It is also essential that the seam-welding operation should be completed immediately after the tack-welding operation is finished, as if tack-welded joints are allowed to stand for any length of time, an oxide film may form between the overlapped faces of the unsealed joint. Such a joint, when finally welded, would show no visible defects while in metal finish only, but during enamelling these impurities would be released, causing considerable "blowhole" defects at the weld line.

In the light of experience, even with close control of all of the above salient points, the percentage of reject vitreous-enamelled ware on seam-welded articles has at all times been much greater than that on similar articles when flash welding is employed. This remark applies to high-grade ware finished in pastel shades, where no visible defects are permissible. It is, however, acknowledged that seam welding has a very useful place in the production of parts (especially cylindrical forms where flash welding cannot be applied) where slight enamel defects have no detrimental effect on the finished product.

Well-designed articles, however carefully produced, either by press or other means of fabrication, have still to be enamelled. Therefore, to ensure a first-class finished article, equal care and thought must be given to the design of tooling and handling equipment necessary for the vitreous enamelling process. Regarding the latter point, proper design of firing tools is most essential to support the article correctly, with a minimum of area contact to avoid excess marking and cold spots, during firing.

IV—ENAMELLER'S VIEWPOINT OF DESIGN

By T. J. MacArthur

The final design of components and assemblies for vitreous enamelling should be decided by consultation between the leading personnel of all the sections concerned. The designer of the appliance is primarily interested in the working efficiency and sales appeal of the product. The press-shop or foundry personnel are concerned with producing the part efficiently, with freedom from severe technical troubles, and, after enamelling, the parts should be easy to fit. The management of a company operating all phases of production should consider the requirements of all departments before making a final decision on design.

It may sometimes be considered desirable to incur some extra material or time cost in one department in order to make considerably greater savings in others. At this point it is as well to consider a very important factor. A part that is scrapped in the enamelling plant or fitting shop through bad design that does not permit easy handling in processing, carries with it the cost of all the operations it has received up to that point. Vitreous enamelling is initially an expensive operation, although the properties of this finish enhance the appearance of iron and steel and greatly extend the life of an appliance, therefore showing a long-term saving. These introductory remarks should emphasise how important a contribution is made by correct design to the successful application of vitreous enamel.

The materials with which we are mainly concerned are grey-iron castings and components fabricated by various methods from sheet steel. These may be used to serve various functions on the same appliance, but for enamelling purposes should not be prefabricated together on the same component.

There are many factors to consider when deciding whether sheet steel or cast iron should be used for a particular shape or part. The trend in domestic cooking equipment design has been to replace castings by sheet-steel pressings wherever this could be done without sacrificing the strength or life of an appliance. Sheet steel lends itself more readily to fast fabrication and enamelling production on such components as cooker side panels, linings, doors, cover tops and most other parts where the component is not subjected to high temperatures during use.

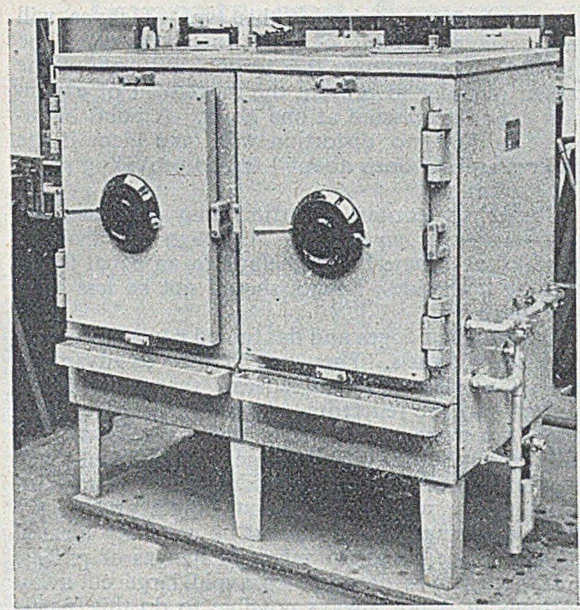

FIG. 6.—*Large Cooker with Cast Grey-iron Doors encased in Enamelled-steel Jackets.*

Generally speaking, grey-iron castings are used for the manufacture of solid-fuel ranges, fire-surround castings, heating stoves, cooker hot plates and front frames, etc. In some cases it may be essential to build part of an appliance from heavy castings as with fronts and doors of canteen cookers, steaming ovens and similar large apparatus. These castings are both costly and difficult to enamel to a high standard of finish. The method of door operation renders suitable enamelling design almost impossible and fracturing losses during processing are high. Great reductions in initial cost and scrap losses have been effected by making the doors from grey-iron castings and enclosing them in enamelled-steel jackets (Fig. 6). The door-operating mechanism on this type of appliance is operated by turning handles set into a solid cast-iron disc of $1\frac{1}{2}$-in. section. These castings may be covered by an enamelled sheet-steel spinning of simple design. It is generally true to say that it is much more expensive to enamel by wet process a heavy casting than to make, enamel and assemble a sheet-steel cover-piece.

Cast Iron

When designing cast-iron parts for vitreous enamelling, it is essential to bear in mind that the casting will be heated one or more times to temperatures between 700 and 800 deg. C.

During heating the casting will expand and pronounced changes in thickness of section or acute changes of direction of shape will cause distortion and liability of fractures occurring (Fig. 7). All changes of direction of shape should be curved, the radius being as large as possible on edges, corners and the roots of lugs and ribbed sections. Radius of inner and outer corners spreads expansion stresses. Sharp inner and outer corners will concen-

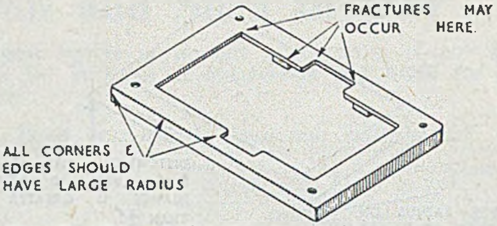

FIG. 7.—*Points of a Casting liable to become Distorted or Fractured during Heating.*

trate expansion stress and cause fractures to occur Fig. 8 (*a*) and (*b*)).

A common lapse from good design is the practice of incorporating relatively heavy fixing lugs on the back of light castings. This causes local porosity and boiling or blistering of the enamel on the face of the casting opposite the lugs. The fault can be avoided by reducing the size of lugs to a minimum and drilling the lugs to the root before enamelling (Fig. 8 (*c*) and (*d*)). Design of castings for domestic appliances has improved greatly during the past 20 years, and possibly this is due in no small measure to the requirements of the enamelling process, but it is still common to see many examples of the faults mentioned. Many range fronts are designed having $\frac{1}{4}$-in. section with sharp cornered oven-door openings, heavy hinge lugs, fixing lugs and heavy ribs cast on the back in an endeavour to avoid distortion.

The total weight and therefore the enamelling cost of many of these castings could be considerably reduced and an improvement in appearance obtained by changing from angular to curved designs (Fig. 8 (*e*) and (*f*)). Radius flanges increase the strength of a casting and are much preferred to ribs set back from the edges.

Handling costs should be considered in the initial stages of casting design, bearing in mind the type of furnace used in the enamelling plant and consequently the most suitable method of supporting the casting during firing. Pieces to be enamelled on all faces should carry light-section, drilled lugs or have

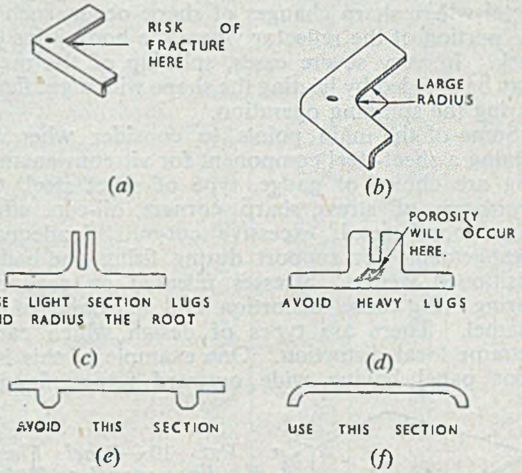

FIG. 8.—*Design Details of Castings which Require Attention in Vitreous Enamelling, showing also what to avoid.*

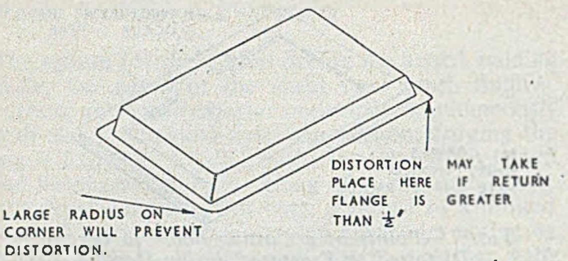

FIG. 9.—*Flanged Door-panel, illustrating the Importance of Radii at the Corners.*

holes in suitable positions in order to allow them to be fired in a hanging position. In some cases this system can be extended to the practice of hanging several pieces one from another, with a consequent increase in furnace loading and saving in expensive firing fixtures. In the production of enamelled castings, bad design is of much greater concern than metal composition. It would appear that some wide latitude of variation in metal composition is permissible, but bad design is always fatal.

Sheet Steel

During recent years the introduction of titanium enamels has vastly improved the technique of enamelling sheet steel. Thinner application coupled with lower firing temperatures has made it possible for shapes of lighter gauge to be enamelled satisfactorily. In the case of shapes such as refrigerator linings where distortion was a major problem, lower temperatures and a less number of firing operations have reduced the problem.

In general, the principles of good design have not changed. Gauge of sheet used should be sufficient to impart rigidity to the shape. The strength of any given gauge of sheet will be increased by forming shapes such as embossed panels, swaging, flanging and half-beading. Deep spinnings or pressings such as reflectors may be made from light gauge material and be satisfactory as regards strength and rigidity. Care must be taken to avoid over-thinning of the metal where sharp changes of shape occur, such as the portion of the reflector where the body joins the neck. In very severe cases, splitting of the metal may be avoided by heating the shape with a gas flame during the spinning operation.

Some of the main points to consider when designing a sheet-steel component for vitreous enamelling are choice of gauge, type of sheet steel, the avoidance of stress, sharp corners, oil-can effect from loose metal, excessive cut-outs, inadequate arrangements for support during firing, and badly-positioned welds. Stresses released or produced during firing cause distortion and hairlining of the enamel. There are types of design which cause extreme local distortion. One example of this is a door panel having wide outward return flanges, expansion during firing of this type of shape will cause severe buckling of the corners. Fig. 9). One method of overcoming this trouble is to radius the corner in order to prevent the movement of expansion exerting pressure at one point. A point of interest is that no distortion will take place if the corners are left open about ⅛ in., so providing space for expansion.

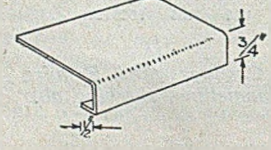

FIG. 10.—*Panel Flange large enough to Reduce Risk of Hairlines.*

Corner to corner distortion may be caused by shallow flanges on panels. Although this may be partially overcome by enamelling to an equal thickness on both sides, flanges should not be less than ¼ in. deep.

Beads, rolled edges and flat folded edges should be avoided on panels. They may be used to advantage on cylindrical or symmetrical shapes such as hollow-ware or reflectors. In the latter case, half-beads are more acceptable to the enameller than a fully closed bead. Where flanges are used, cut-away portions should be carefully designed in order to avoid severe weakening of the flanges and consequent chipping. Holes should be carefully located and not placed near the edges of flanges or panels.

Although it is desirable to avoid large cut-away portions, it is not always possible to do this, particularly in the case of backs of refrigerator linings. The weakness and loose metal thus imparted should be reduced by forming a continuous flange around the edges of the cut-out section.

Flanges of panels should be continuous, and if formed by notching and folding, the corners should be welded. Open corners on flanged panels will cause hairlining and chipping. Edges of flanges and embossed sections should be given as large a radius as possible. Flanges having an inward return bend should not be less than ¾ in. deep and the width of the inward return should not be greater than ½ in. The width of the return can be increased in ratio with increase in depth of the vertical flange (Fig. 10). This will reduce the risk of hairlines appearing on the face adjacent to the flange.

Welded assemblies for vitreous enamelling are probably the most common, but the limited scope of this Paper does not permit a thorough description of the various techniques employed. Assemblies to be welded should be of uniform thickness and joints should be made on a flat surface away from corners to permit easy access for weld dressing in cases such as oven and refrigerator linings where the shape is enamelled on the inside. On shapes such as box-sectioned letters for signs where the finish is applied to the outside; welding on corners and edges of folds will cause excessive chipping.

Light-gauge attachments may be spot-welded to rigid assemblies, and where this is done, the part should be designed to present the lowest possible area of double thickness. Corner brackets spot-welded to refrigerator linings impart greater strength to the assembly and reduce the tendency for hairlining to occur at open corners. Spot-welding may be used to form an overlapped joint on surfaces not normally visible. The spot-welds should be kept close together and with the use of highly opaque titanium enamels this type of joint should be quite safe. Sufficient opacity and covering should be

(*Continued on page* 26)

Imports and Exports of Iron and Steel in May

The following tables, based on Board of Trade returns, give figures of imports and exports of iron and steel in May. Figures for the same month in 1950 are given for purposes of comparison and totals for the first five months of this year and of 1950 are also included.

Total Exports of Iron and Steel

Destination.	Month ended May 31. 1950.	Month ended May 31. 1951.	Five months ended May 31. 1950.	Five months ended May 31. 1951.
	Tons.	Tons.	Tons.	Tons.
Channel Islands ..	653	1,059	3,481	3,643
Gibraltar	145	50	751	271
Malta and Gozo ..	245	179	2,218	1,049
Cyprus	1,098	613	3,861	2,293
Sierra Leone	334	422	1,759	1,317
Gold Coast	2,051	2,015	12,527	8,358
Nigeria	8,452	6,003	27,679	25,772
Union of South Africa	16,071	11,533	68,593	60,065
Northern Rhodesia ..	3,019	1,354	12,308	7,086
Southern Rhodesia ..	6,376	3,902	31,702	14,697
British East Africa ..	10,622	6,740	41,995	36,458
Mauritius	692	540	3,772	3,204
Bahrein, Kuwait, Qatar and Trucial Oman..	724	908	3,051	3,664
India	7,920	8,431	35,325	42,965
Pakistan	9,335	7,453	33,185	38,466
Malaya	10,535	7,558	36,434	31,655
Ceylon	3,408	2,545	16,044	13,294
North Borneo ..	409	1,002	2,964	1,954
Hongkong	4,416	8,454	22,655	31,399
Australia	36,462	27,393	133,147	156,465
New Zealand ..	16,250	4,829	71,315	53,373
Canada	21,676	25,045	57,073	101,297
British West Indies ..	2,960	7,106	26,271	26,205
British Guiana ..	1,116	1,047	3,655	2,829
Anglo-Egyptian Sudan	1,310	844	7,323	4,266
Other Commonwealth	952	850	6,280	5,219
Irish Republic ..	9,599	10,853	39,220	41,608
Soviet Union ..	116	520	411	2,170
Finland	7,066	2,821	27,410	16,232
Sweden	8,796	9,230	38,485	42,545
Norway	9,798	5,528	35,754	29,351
Iceland	559	450	2,169	1,238
Denmark	9,207	6,547	62,980	39,463
Poland	311	128	927	508
Germany	37	85	188	503
Netherlands	7,151	6,191	34,332	37,463
Belgium	1,043	1,100	6,071	5,979
France	2,673	311	10,836	3,651
Switzerland	970	1,766	5,676	5,755
Portugal	1,491	431	8,115	7,521
Spain	372	289	3,733	1,855
Italy	1,275	6,689	4,044	14,253
Austria	116	72	500	245
Hungary	43	—	258	23
Yugoslavia	107	305	3,119	5,007
Greece	334	231	2,879	1,373
Turkey	770	771	4,564	2,065
Indonesia	594	546	7,436	2,742
Netherlands Antilles..	106	380	4,047	1,561
Belgian Congo ..	106	449	921	1,059
Angola	159	520	1,248	1,313
Portuguese E. Africa..	650	376	2,113	1,768
Canary Islands ..	53	229	800	679
Syria	91	71	546	559
Lebanon	541	689	5,270	6,239
Israel	1,822	2,642	7,517	11,516
Egypt	3,616	3,105	28,327	17,122
Morocco	1,346	15	1,563	1,280
Saudi Arabia	279	57	1,227	173
Iraq	4,536	2,821	19,887	11,124
Iran	12,607	11,078	51,842	40,465
Burma	966	1,325	4,513	6,078
Thailand	451	1,152	2,910	7,028
China	351	350	951	4,433
Philippine Islands ..	561	358	5,539	1,645
U.S.A.	3,062	11,768	7,553	86,857
Cuba	118	338	559	2,251
Colombia	400	287	2,409	3,150
Venezuela	2,241	2,993	16,415	14,142
Ecuador	316	126	1,278	497
Peru	1,374	760	4,238	4,698
Chile	1,537	1,035	7,752	5,102
Brazil	1,773	2,630	12,470	10,484
Uruguay	1,147	242	4,359	7,037
Argentina	4,620	1,516	29,746	21,426
Other foreign ..	1,213	1,167	7,736	8,287
TOTAL ..	275,701	241,218	1,197,911	1,216,787

Total Imports of Iron and Steel (tons)

From	Month ended May 31. 1950.	Month ended May 31. 1951.	Five months ended May 31. 1950.	Five months ended May 31. 1951.
India	—	—	22,896	1
Canada	4,330	4,758	17,386	19,269
Other Commonwealth and Irish Republic	116	181	803	625
Sweden	849	2,123	5,234	9,004
Norway	6,089	4,959	21,229	21,127
Germany	7,745	1,508	39,809	6,682
Netherlands	6,674	12,589	28,479	28,093
Belgium	6,813	14,829	38,271	55,669
Luxemburg	4,887	7,566	17,073	34,697
France	35,174	16,622	109,473	97,189
Austria	6	3,008	2,261	7,960
U.S.A.	5,248	1,813	29,080	15,311
Other foreign ..	100	98	2,740	724
TOTAL ..	78,031	70,054	334,734	296,351
Iron and steel scrap and waste, fit only for the recovery of metal	207,534	27,737	994,714	276,787

Exports of Iron and Steel by Products (tons)

Product.	Month ended May 31. 1950.	Month ended May 31. 1951.	Five months ended May 31. 1950.	Five months ended May 31. 1951.
Pig-iron	960	2,095	11,630	12,144
Ferro-alloys, etc.—				
Ferro-tungsten ..	107	37	508	254
Spiegeleisen, ferro-manganese ..	130	23	964	562
All other descriptions	81	87	682	534
Ingots, blooms, billets, and slabs	1,299	693	2,715	4,314
Iron bars and rods ..	503	1,175	2,275	4,030
Sheet and tinplate bars, wire rods ..	72	1,338	1,235	6,048
Bright steel bars ..	3,322	2,900	16,801	18,680
Alloy steel bars and rods	1,300	1,154	6,132	6,882
Other steel bars and rods	20,791	17,322	98,312	100,520
Angles, shapes, and sections	12,843	11,904	61,449	82,094
Castings and forgings	678	1,172	3,860	4,571
Girders, beams, joists, and pillars	9,301	2,964	26,486	17,788
Hoop and strip ..	11,593	6,595	40,790	30,432
Iron plate	356	258	1,258	991
Tinplate	26,216	17,605	103,249	104,446
Tinned sheets.. ..	174	302	1,105	1,417
Terneplates, decorated tinplates	115	206	227	575
Other steel plate (min. ⅛ in. thick) ..	30,646	29,983	124,397	130,362
Galvanised sheets ..	9,128	3,671	47,302	26,556
Black sheets	13,817	15,333	57,240	64,062
Other coated plate ..	1,122	1,093	5,049	4,158
Cast-iron pipes up to 6 in. dia.	7,592	8,494	32,601	32,377
Do., over 6 in. dia. ..	6,856	6,312	35,441	29,873
Wrought-iron tubes ..	30,274	38,234	146,288	169,360
Railway material ..	31,206	18,246	120,126	103,181
Wire	6,725	4,428	28,503	28,171
Cable and rope ..	2,392	3,126	13,738	13,197
Wire nails, etc. ..	1,692	1,876	7,156	12,744
Other nails, tacks, etc.	527	443	2,044	1,909
Rivets and washers ..	856	563	3,251	2,812
Wood screws	389	382	1,510	1,636
Bolts, nuts, and metal screws	2,872	2,055	12,829	11,574
Baths	1,667	1,315	5,997	5,827
Anchors, etc.	908	883	3,856	3,835
Chains, etc.	950	873	4,192	4,409
Springs	912	726	4,175	2,787
Hollow-ware	6,518	2,965	37,580	16,215
TOTAL, including other manufactures not listed above ..	275,701	241,218	1,197,911	1,216,787

News in Brief

MARSHALL SONS & COMPANY, LIMITED—Mr. Arthur Makin has been elected to the board.

THE REPUBLIC OF IRELAND imported 830 tons of pig-iron, valued at £12,213, in March, against 799 tons (£12,761) in March, 1950.

ARRANGEMENTS ARE BEING MADE for the London County Council's "South Bank, Past and Present" exhibition to be transferred from County Hall to the Royal Festival Hall.

MR. AND MRS. KENNETH JEWSON, of Dereham, last Friday afternoon held a reception at Charing Cross Hotel at which many of their London area business friends were present.

THE BRITISH INSTITUTE OF MANAGEMENT, after a study, have found that there is an absence of standardisation of the titles used to designate a foreman. Now what are they going to do about it?

MUSGRAVE & COMPANY, LIMITED, St. Ann's Works, Belfast, announce the appointment of Mr. G. W. Stevenson as manager of their new branch office opened at 297, Hagley Road, Birmingham 17.

REPRESENTATIVES FROM 66 countries participated in a sales conference organised by Hoover, Limited, and held recently at the Savoy Hotel, London. Sir Charles Colston, chairman and managing director, welcomed the delegates and Mr. F. H. Bunn presided.

THE WOLVERHAMPTON METAL COMPANY, LIMITED, of Wednesfield, have made the following appointments to the Board: Mr. T. C. James (managing director) has been appointed vice-chairman; and Mr. E. W. Snowdon, Mr. F. W. James, and Mr. K. R. H. James, A.C.A., have been appointed directors.

MR. J. H. JOLLY, chairman of Guest, Keen & Nettlefolds, Limited, told shareholders at last week's meeting at Birmingham that the group's total holding of £18,500,000 3½ per cent. Iron and Steel stock, received as compensation, had now been realised at an average price of approximately £98 per £100 of stock.

WORK HAS BEEN RESUMED on the recovery of steel scrap from the blockships lying at the eastern approach to Scapa Flow. The former German vessel, Ilsenstein, is being cut up and the bronze propellors have already been salved from other ships. The blockships had become redundant since the wartime erection of the Churchill causeway, which seals this entrance to the Flow.

IN ADDITION to maintaining the dividend at 15 per cent., less tax, on the £1,857,625 ordinary shares, with an unchanged final dividend of 11 per cent., William Baird & Company, Limited, recommends a tax-free dividend of 5s. per £1 unit out of the capital profits arising from the transfer of the shares in Bairds & Scottish Steels, Limited, to the Iron and Steel Corporation of Great Britain.

DETAILS OF PROPOSALS by Associated Electrical Industries, Limited, for the conversion of 8½ per cent. preference stock into 4½ per cent. preference stock, and the issue of further ordinary and 4½ per cent. preference shares were posted to stockholders on July 3. Separate meetings of preference and ordinary stockholders and an extraordinary meeting will be held on July 27.

TERMS ARE ANNOUNCED on which the Glacier Metal Company, Limited, is to raise the new money referred to previously. Subject to passing of resolutions on July 4, the directors propose to issue 140,000 6 per cent. £1 cumulative preference shares at 24s. and 840,000 5s. ordinary shares at 6s. 3d. Provisional allotment letters will be posted after the meetings. The issues should provide approximately £430,000.

DURING 25 YEARS' SERVICE to the shipbuilding and engineering trades, over 600 marine boilers of all types, manufactured by the Clarkson Thimble Tube Boiler Company, Limited, London, have been fitted to Diesel-engined ships for waste-heat recovery and as oil-fired units. The total number of all types of boilers supplied by the company during this period, for both marine and industrial installations, exceeds 3,700.

THE BRITISH WELDING RESEARCH ASSOCIATION announces the following staff changes:—Dr. N. Gross, PH.D.(CANTAB.), A.M.I.MECH.E., has been appointed assistant director of research and will remain in charge of the research station at Abington; Dr. K. Winterton, PH.D., B.SC., and Mr. H. E. Dixon, M.SC., have been appointed chief metallurgists for ferrous and non-ferrous respectively; and Mr. C. L. M. Cottrell, M.SC., and Mr. P. T. Houldcroft, B.SC., have been appointed assistant chief metallurgists for the same groups.

FOR 140 YEARS, only employees at Durie Foundry, Leven, passed through the gates; no outsiders were ever shown over the works. That was until June 26, when, as a contribution to the town's Festival Week, the firm allowed relatives to see over the various departments. At tea in the works canteen, Mr. Lindsay Burns, jun., director and general manager of the firm, Henry Balfour & Company, Limited, gas and chemical engineers, said it was hoped to hold further visiting days to help local people to understand that the foundry was now an engineering centre of world-wide importance on which much of Leven's prosperity depended and in which the district's youth could become skilled in almost every branch of engineering.

Design for Vitreous Enamelling

(*Continued from page* 24)

gained with these enamels without bridging the overlapped joint and chipping should thus be avoided.

The adoption of the continuous furnace has brought a new factor to be considered in the design of parts for enamelling. Consideration must be given to achieving a high rate of furnace loading. Particular importance should be given to this factor and parts should be designed so that they will handle easily on conveyor systems and keep shape whilst being supported from the furnace conveyor. The most simple method of hanging is to incorporate a small return flange on the corners of panels. These flanges may only be required on the corners of flanges bounding the short sides of large panels and table tops. On small panels it may be an advantage to flange all four corners in order to hang one piece from the bottom of another. Fitting holes may be adapted for hanging, but on some large assemblies it will be found necessary to spot-weld brackets for the sole purpose of handling during enamelling.

Many of the design faults mentioned may be partially or wholly overcome during enamelling by brushing the covercoat from weak points such as sharply-formed flanges, badly-located holes and weak corners. Brushing is a very expensive operation and unless it is required for design purposes, such as signs or decorative patterns, it should be kept down to a minimum. Thin coating applications have greatly reduced the need for brushing, particularly around fixing holes and flanges. The combination of correct design and highly-opaque enamels should in time eliminate the cost of this operation, except cases where enamel thickness must be highly controlled for assembly purposes.

Raw Material Markets

Iron and Steel

Deliveries of both pig-iron and scrap remain restricted, and it is impossible to satisfy the needs of the foundries from available supplies. The jobbing and light foundries are well provided with work, while the general engineering, motor, and textile foundries have heavy commitments, castings for home requirements being supplemented by large orders for the export market, and new business is constantly being offered. Slight relief has been given to the foundries using hematite pig-iron, improved deliveries confirming the reported increase in ore deliveries. Producers of hematite, however, are still restricted, most furnaces working on slack blast, with the result that orders on hand are heavily in arrears.

The foundries need much larger tonnages to make up for the shortage of the low- and medium-phosphorus irons, and present deliveries of other grades fall short of actual needs. The jobbing and light foundries are in need of more high-phosphorus pig-iron; additional supplies may be expected from the Derbyshire area, where another furnace is now in blast following relining. Most of these foundries are very short of this grade of pig-iron and there will be a heavy demand for any increased tonnage.

Both cast-iron and steel scrap for cupola use are in heavy demand, and the current shortage compels many foundries to use larger quantities of pig-iron in their mixtures. Foundry coke is coming forward in fairly satisfactory tonnages, while ganister, limestone, and firebricks are freely available. Supplies of some ferro-alloys remain difficult.

Some re-rollers have received parcels of Continental steel semis during the last few weeks, but these have not been in appreciable quantities and fail completely to make up the shortage from home steelworks. The latter are under heavy pressure for supplies of billets, blooms, and slabs, and for any defectives or crops which arise. The re-rollers of sheets, whose commitments are exceptionally heavy, are also suffering from a shortage of sheet bars.

The increasing shortage of suitable scrap, coupled with the continuous reduction in pig-iron supplies, has again made itself felt in the quantity of iron produced. In spite of this, the demand for iron bars shows no sign of slackening, as more and more consumers are endeavouring to substitute iron in place of steel wherever this is possible.

Non-ferrous Metals

Although it has seemed as if the United States might be considering a re-entry to the world's tin market, the London market has again been rather easy. Last week's turnover was moderate, and consumers showed interest at the lower levels, but, on the whole, users are inclined to display caution and await events. There is a feeling that at $1.03 the U.S. authorities would be prepared to buy freely. This price is equal to about £824 per ton, a level which the market has not reached, even for the forward position. It has been suggested that a price below £900 would make it very hard for some producers to operate without loss. Even allowing for an increase in costs since the outbreak of the Korean war, it seems unlikely that the situation is as desperate as it is sometimes made out to be. The history of non-ferrous metals over the years affords examples of production persisting at a fairly good rate in spite of prices ruling at what might well be called starvation levels. Base metal shares seem to be well thought of on the Stock Exchange today, and the profits earned by mining companies are, on the whole, excellent.

Official tin quotations on the London Metal Exchange were as follow:—

Cash—Thursday, £930 to £935; Friday, £905 to £910; Monday, £880 to £890; Tuesday, £900 to £910; Wednesday, £900 to £905.

Three Months—Thursday, £877 10s. to £800; Friday, £850 to £855; Monday, £834 to £835; Tuesday, £848 to £850; Wednesday, £840 to £842 10s.

The Ministry of Supply Scrap Distribution Order is now in operation, and we must now wait to see how the new regulations are going to work out. General opinion seems to be that an improvement is on the way, and it is certainly time that consumers are finding deliveries, against orders arranged some time ago, coming forward rather more briskly. This may well be due to fears of further legislation, but, of course, what is most to be hoped is that the prime holders of scrap, the originators of the metal so to speak, will from now on push their tonnage on to the market, so that the sorely tried fabricators can have a chance to keep their plant running.

What the new Order aims to do is to get scrap moving and into the open. Some people connected with the trade feel that the total tonnage held up is very considerable, but on this point opinions vary. It is certainly a fact that fabricators could do with very much more secondary metal than they are getting.

Secondary Aluminium Prices

Following the introduction of the Aluminium Scrap Prices Order, 1951, and in the absence of a similar Order controlling the prices of secondary aluminium and aluminium-alloy ingots, members of the Federation of Secondary Light Metal Smelters recently adopted a range of maximum selling prices for their products.

The maximum prices adopted on April 9 last were based on the prices of raw materials and production costs at that time, and the federation announces that, as a consequence of the increases in the prices of silicon metal and copper, its members find it necessary to increase the maximum selling prices of the undermentioned alloys for deliveries on and after July 2, as follow:—LM1, from £128 to £129 per ton; LM2, from £145 to £148; LM4, from £132 to £133, and LM6, from £155 to £159.

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.

BRIDGEND, July 27—Provision and laying of approx. 2,183 yds. of 6-in. dia. and 395 yds. of 4-in. dia. cast-iron pipes, together with other work, for the Mid Glamorgan Water Board, Wyndham Street, Bridgend (Glam).

OLD FLETTON, July 14—40 corrugated galvanised-iron water tanks, 150 galls. capacity, complete with 1-in. draw-off tap and 1-in. outlet, for the Rural District Council. Mr. J. E. Clarke, clerk, Council Offices, Old Fletton, Peterborough.

The combined January and February steel output in Spain is returned at 126,261 tons, which compares with 128,885 tons in the corresponding period of 1950. Pig-iron output in the first two months was 90,872 (103,261) tons, while coal production totalled 1,893,000 (1,986,000) tons. Production of Spanish and Rif ores in February last totalled 240,947 tons, compared with 228,594 tons in the opening month of the year and 219,747 tons in December, 1950.

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

(Delivered, unless otherwise stated)

July 4, 1951

PIG-IRON

Foundry Iron.—No. 3 Iron, Class 2:—Middlesbrough, £10 17s. 9d.; Birmingham, £10 13s.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £12 9s., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si)—North Zone, £12 16s. 6d.; South Zone, £12 19s.

Scotch Iron.—No. 3 foundry, £12 7s. 9d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £13 7s. 6d.; South Zone, £13 10s.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £13 17s. 6d.; South Zone, £14.

Cold Blast.—South Staffs, £16 10s. 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 7s. 6d.; Scotland, £12 14s.; Sheffield, £13 2s. 6d.; Birmingham, £13 9s.; Wales (Welsh iron), £12 7s. 6d.

Spiegeleisen.—20 per cent. Mn, £18 3s.

Basic Pig-iron.—£10 19s. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered.)

Ferro-silicon (6-ton lots).—40/55 per cent., £37 15s., basis 45% Si, scale 14s. per unit; 70/84 per cent., £52, basis 75% Si, scale 14s. 6d. per unit.

Silicon Briquettes (5-ton lots and over).—2lb. Si, £44 2s.; 1lb. Si, £45 2s.

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., 35s. 9d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 37s. 9d. per lb. of W.

Ferro-chrome (6-ton lots).—4/6 per cent C, £66, basis 60% Cr, scale 22s. per unit; 6/8 per cent. C, £61, basis 60% Cr, scale 21s. per unit; max. 2 per cent. C, 1s. 6¾d. per lb. Cr; max. 1 per cent. C, 1s. 7¼d. per lb. Cr; max. 0.15 per cent. C 1s. 8d. per lb. Cr.; max. 0.10 per cent. C, 1s. 8¼d. per lb. Cr.

Chromium Briquettes (5-ton lots and over).—1lb. Cr, £69 4s.

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., £37 19s. 10d.

Manganese Briquettes (5-ton lots and over).—2lb. Mn, £46 18s.

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

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—Basic: Soft, u.t., £17 4s.; tested, up to 0.25 per cent. C (100-ton lots), £17 9s.; hard (0.42 to 0.60 per cent. C), £19 4s.; silico-manganese, £24 6s. 6d.; free-cutting, £20 9s. Siemens Martin Acid: Up to 0.25 per cent. C, £22 11s. 6d.; case-hardening, £23 9s.; silico-manganese, £26 14s.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £20 4s.; basic, hard, over 0.41 up to 0.60 per cent. C, £21 9s.; acid, up to 0.25 per cent. C, £23 9s.

Sheet and Tinplate Bars.—£17 6s. 6d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £21 3s.; boiler plates (N.-E. Coast), £22 10s. 6d.; chequer plates (N.-E. Coast), £23 8s.; heavy joists, sections, and bars (angle basis), N.-E. Coast, £20 1s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £22 15s.; flats, 5 in. wide and under, £22 15s.; hoop and strip, £23 10s.; black sheets, 17/20 g., £29 13s.; galvanised corrugated sheets, 17/20 g., £43 6s.

Alloy Steel Bars.—1-in. dia. and up: Nickel, £37 19s. 3d.; nickel-chrome, £56 6s.; nickel-chrome-molybdenum, £63 1s.

Tinplates.—48s. 3½d. 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, £900 to £905; three months, £840 to £842 10s.; settlement, £900.

Zinc.—G.O.B. (foreign) (duty paid), £160; ditto (domestic), £160; "Prime Western," £160; electrolytic, £164; not less than 99.99 per cent., £166.

Lead.—Good soft pig-lead (foreign) (duty paid), £160; ditto (Empire and domestic), £160; "English," £161 10s.

Zinc Sheets, etc.—Sheets, 15g. and thicker, all English destinations, £180; rolled zinc (boiler plates), all English destinations, £178; zinc oxide (Red Seal), d/d buyers' premises, £178.

Other Metals.—Aluminium, ingots, £124; antimony, English, 99 per cent., £390; quicksilver, ex warehouse, £73 10s. to £74; nickel, £454.

Brass.—Solid-drawn tubes, 24⅓d. per lb.; rods, drawn, 27d.; sheets to 10 w.g., 28⅞d.; wire, 30½d.; rolled metal, 27⅝d.

Copper Tubes, etc.—Solid-drawn tubes, 26¾d. per lb.; wire, 261s. 9d. per cwt. basis; 20 s.w.g., —s. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £285; BS. 1400—LG3—1 (86/7/5/2), £302; BS. 1400—G1—1 (88/10/2), £369; Admiralty GM (88/10/2), virgin quality, —, per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £379; L.P.Bl, £322 per ton.

Phosphor Bronze.—Strip, 39d. per lb.; sheets to 10 w.g., 41½d.; wire, 43¼d.; rods, 39d.; tubes, 44d.; chill cast bars: solids —, cored, —. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Ingots for raising, 2s. 6½d. per lb. (7%) to 3s. 6¾d. (30%); rolled metal, 3 in. to 9 in. wide × .056, 3s. 0½d. (7%) to 4s. 0¾d. (30%); to 12 in. wide × .056, 3s. 0¾d. to 4s. 1d.; to 25 in. wide × .056, 3s. 2¾d. to 4s. 3d. Spoon and fork metal, unsheared, 2s. 9½d. to 3s. 9¾d. Wire, 10g., in coils, 3s. 6¼d. (10%) to 4s. 6¼d. (30%). Special quality turning rod, 10%, 3s. 5¼d.; 15%, 3s. 10¼d.; 18%, 4s. 2¾d. All prices are net.

Personal

In our issue of June 21 we regret that the name of the joint managing director of Birmingham Aluminium Casting (1903) Company, Limited, was quoted as Mr. J. W. Benny; this should read Mr. J. W. Berry.

Mr. W. Todd who has relinquished his position as works manager at the Simplex Electric Company, Limited, Blythe Bridge, has joined the staff of John Gardom & Company and will be responsible for factory heating and ventilating and management.

Mr. Walter L. Seelbach, the president-elect of the American Foundrymen's Society and president of the Superior Foundry Inc. of Cleveland, Ohio, together with Mr. C. R. Culling, president of the Carondelet Foundry Company of St. Louis, Mo., are to participate in the International Foundry Congress to be held at Brussels in September. They will be accompanied by their wives.

Succeeding the late Mr. W. G. A. Perring as director of the Royal Aircraft Establishment, Farnborough, is 36-year-old Prof. A. A. Hall, head of the Department of Aeronautics, Imperial College of Science and Technology, London. Zaharoff Professor of Aviation at London University and a member of the Air Safety Board and the Aeronautical Research Council, Prof. Hall was chief scientific officer at Farnborough from 1938 to 1945.

Among the members of a committee appointed by the Minister of Local Government and Planning, Mr. Hugh Dalton, to help in the revision of the department's model byelaws, which are issued for the guidance of local authorities in framing under the Public Health Act byelaws governing the erection of new buildings, are:—Mr. P. Cutbush (British Standards Institution), Mr. C. L. a'Court (Federation of British Industries), and Mr. L. E. Kent (Institution of Structural Engineers).

Obituary

G. GEOFFREY SMITH, M.B.E.

By the death of G. Geoffrey Smith, M.B.E., which occurred on Friday, June 29, at his home at Radlett, Herts., technical journalism loses one of its best-known figures. He was 66 years old. After an engineering apprenticeship with Ransome & Marles, Limited, he joined the editorial staff of *The Motor Cycle*. This was in 1904; only eight years later he became Editor. For organising mobile transport in the 1914/18 war he was made an M.B.E. in 1917. Later, he assumed direction of a number of Iliffe Journals. He was a Freeman of the City of London, a Liveryman of the Worshipful Company of Coachmakers and Coach Harness Makers, and a Life Governor of the Great Ormond Street Hospital for Sick Children.

A foreman at the Elswick works of Vickers-Armstrongs, Limited, for 41 years, Mr. John Dawson has died at the age of 71.

Mr. James Wallace, the managing director of J. & R. Wallace, Limited, agricultural engineers and ironfounders, of Castle Douglas (Kirkcudbrightshire), died on June 13.

The death occurred on June 25 of Mr. Francis A. Bolton, who was associated with Thomas Bolton & Sons, Limited, copper smelters and refiners, etc., of Widnes (Lancs).

Mr. James E. Wilson, managing director of James Wilson (Huddersfield), Limited, died on June 23, aged 64. He had been very actively engaged in the ironfounding industry for the past 50 years.

Col. A. W. Ward-Walker, who joined W. Newman & Sons, Limited, brassfounders, door spring manufacturers, etc., of Birmingham, in 1904 as an office boy and became general manager in 1936, died recently.

CLASSIFIED ADVERTISEMENTS

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

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

SITUATIONS WANTED

FOUNDRY MANAGER, desiring change, seeks post in Birmingham, Wolverhampton area. Experienced in all aspects of foundry work. Sound practical and technical qualifications. M.I.B.F. and A.M.I.P.E.—Box 1066, FOUNDRY TRADE JOURNAL.

PATTERN MOULDER, 30 years' experience light castings, medium engineering, etc., seeks position, Yorkshire preferred. Green labour taught plate or machine moulding.—Box 1075, FOUNDRY TRADE JOURNAL.

FOUNDRYMAN AND METALLURGIST. B.Sc. (Bombay), A.M.B.I.F., M.A.S.M.. holding diploma of National Foundry College, U.K. Seeks opportunity with firms in India or Pakistan producing ferrous, non-ferrous castings and alloys. Would also consider position as representative or technical adviser. Seven years' experience in non-ferrous, refining, alloying, castings. At present in England, having practical experiences in various firms dealing with ferrous and non-ferrous castings, also die and centrifugal castings. Box 1086, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

FOREMAN required for Malleable Ironfoundry.—Apply in writing, with full details as to age, experience, salary, etc., to HALE & HALE (TIPTON), LTD., Dudley Port, Tipton, Staffs.

FOUNDRY FOREMAN required for fully mechanised foundry, producing Iron and Steel Castings up to 10 cwts. Applicants must have previous experience of this class of work and be able to organise unskilled operators. The post is permanent, and a good salary will be paid to successful applicant. Single man preferred on account of accommodation difficulties.—Apply Box 1076, FOUNDRY TRADE JOURNAL.

FOUNDRY SUPERINTENDENT required for South Midlands. Must have thorough practical experience in electric melting of special steels and alloys to close specification; preferably also sand casting. Able to control labour. A.I.M. or equivalent. Permanent post with good prospects and pension scheme. Good salary, according to age and qualifications. —Write in confidence, Box 1078, FOUNDRY TRADE JOURNAL.

EXPERIENCED ASSISTANT WORKS MANAGER with early prospects of promotion, required by Light Castings Foundry in Midlands, melting 200 to 250 tons per week on floor and mechanical plant. Must have technical and practical knowledge, with a progressive outlook and ability to take control.—Reply, stating age, full details of experience and salary required, to Box 1081, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

TWO able and keen FOUNDRY TECHNICIANS required for servicing well-known bonding material. Practical experience essential. One about 28-32 years of age, the other 24-25. Salaries not less than £550 and £450 per annum respectively. Able to drive car. Will work half time in laboratory and half time on servicing.—Good prospects for right men. —Box 1031, FOUNDRY TRADE JOURNAL.

A WELL-KNOWN Chemical Firm in the Midlands requires a TECHNICAL SALES REPRESENTATIVE, who can speak and write Italian, for permanent residence in that country. Applicants should have metallurgical background and some knowledge of foundry work. Some sales experience is desirable.—Apply full particulars, Box 1079, FOUNDRY TRADE JOURNAL.

A VACANCY exists for a fully qualified nightshift SUPERVISOR for our Pressure Diecasting Dept. Applicants must have the following qualifications:— (*a*) Practical Toolmaker to trade and qualified to train and control unskilled labour on Pressure Diecasting Machines and skilled tradesmen manufacturing dies. (*b*) Accustomed to a high standard of work. (*c*) Have the necessary drive and initiative and able to take responsibility. Excellent prospects of a house available. Only fully competent men need apply. This post offers excellent prospects for the right man. Attractive Superannuation Scheme. All applications will be treated in the strictest confidence.—Write, giving full particulars of age, experience, qualifications and salary expected, to PERSONNEL MANAGER, Renfrew Foundries, Ltd., Hillington, Glasgow, S.W.2.

MILITARY College of Science require CIVILIAN INSTRUCTORS (Technical Grade III) (unestablished), to instruct in the following trades: Foundry work (moulding and metal-melting). Smithcraft (hand and power forging and heat treatment), Machining (grinding, surface, cylindrical, gear and cutter, Electrical Winding and Allied Processes. Candidates must have undergone a period of recognised training in their trade, followed by not less than five years' practical experience as skilled craftsmen. Good instructional ability and some teaching experience will be an advantage. Salary is on the range £437-£545. Starting salary will be fixed according to age, qualifications and experience. Annual increases are payable subject to satisfactory service. An assisted travel scheme is in operation between both Swindon and Faringdon and the College.—Written applications, giving date of birth and education, full details of qualifications and experience of posts held (including dates), should be addressed to APPOINTMENTS OFFICER, Ministry of Labour and National Service, 1-6, Tavistock Square, W.C.1, quoting reference number J.A.17, within 14 days of appearance of this advertisement. In no circumstances should original testimonials be forwarded. Only candidates selected for interview will be advised.

SITUATIONS VACANT—*Contd.*

FOUNDRY ENGINEER, experienced in the design and installation of mechanised steel and iron foundries, required for responsible post with Consulting Engineers in Surrey.—Box 1082, FOUNDRY TRADE JOURNAL.

ESTIMATOR required by Sales Department of Catton & Co., Ltd., Yorkshire Steel Foundry, Leeds, 10. Must have some knowledge of foundry production methods, etc., and ability to read drawings. Write, stating age, experience, and salary required.

FLOOR MOULDERS required for Aluminium Foundry in the South Midlands area. For suitable applicants, accommodation could be arranged.—Box 1084, FOUNDRY TRADE JOURNAL.

WANTED

FOREMAN DRESSER for small Steel Foundry in the North. Output approx. 40 tons per week. Must be energetic young man, capable of running department. Salary start £450 per annum, plus production bonus. Superannuation scheme. Large flat available.—Apply Box 1085, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN required for Ceylon to take charge of Iron and Non-ferrous Foundry turning out general engineering castings. Must have thorough floor and machine-moulding experience and a sound knowledge of pattern making and preparation of plate patterns. Age not over 35 years. Salary equivalent to £1,300 a year is offered for a man with the desired qualifications Terms include Provident Fund benefits and periodical furlough.—Write stating age and giving full particulars of experience, etc., to "JU/182," c/o 95, Bishopsgate, E.C.2.

LARGE Founders in S.E. London have the following posts vacant:—
(*a*) METALLURGIST for work in connection with the production of cast iron and copper base materials.
(*b*) METALLURGIST for work on light alloys. Applicant with knowledge of aluminium and magnesium base alloys used for castings will be preferred.
(*c*) METALLURGIST for investigations on non-ferrous alloys in Research Laboratory. Applicant should have a good degree in metallurgy or equivalent qualification, or alternatively a degree in physics or chemistry with metallurgical experience.
(*d*) RADIOLOGISTS for X-ray inspection of castings. Applicant, with experience in the interpretation of radiographs of light alloy castings will be preferred.
Salaries according to qualifications and experience.—Write PERSONNEL MANAGER, Messrs. J. Stone & Co. (Charlton), Ltd., Woolwich Road, Charlton, London, S.E.7.