FOUNDRY TRADE JOURNAL

Established 1902

Vol. 91 | Thursday, November 29, 1951 | No. 1839

PRINCIPAL CONTENTS

PUBLISHED WEEKLY : Single Copy, 9d. By Post 11d. Annual Subscription, Home 40s., Abroad 45s. (Prepaid).

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

Modernising Foundries

During the recent International Brussels Congress, we had ample opportunity to discuss with American experts the problems to be associated with increased productivity of European foundries. The stress seemed to be laid on streamlining and motorising the processes where possible. It should be clearly understood that the Americans have now thoroughly familiarised themselves with European conditions. They have noted that where modernisation has been attempted there are often three or four men doing a job, when, by the introduction of an available gadget, the crew could be reduced to one or even eliminated. Perhaps the main alteration they envisage is in methods of working. Confining of the knocking-out to one place and preparation of sand during the night could often be introduced with advantage. Mobile plant is highly esteemed for the smaller concerns, as also are lengths of roller conveyors to eliminate bending and walking.

In this connection, we recall that we have often stressed that the introduction of a moulding machine without ancillary services merely converts the operator from a sand rammer into a porter. Complete mechanisation is only recommended for really large-scale enterprises. If the Americans have a fault in this field of mechanisation (although results are all against this hypothesis) it is that in their endeavour to raise production per unit floor space, they are inclined to introduce congestion. This was certainly the case in some of the earlier installations in European foundries, and was especially evident in a Paris and a Birmingham works. We are aware that the best way to manufacture is for a man to carry out an operation and pass the component by hand to the next man in the line. Whilst this is difficult to accomplish in a foundry, the principle should be kept in mind. The best example of this type of work is on the circular rotating table. Other systems employ lengths of conveyor "banks," these mainly providing storage for moulds waiting to be poured.

The jobbing foundries present a different and very difficult problem. The development of green-sand moulding can eliminate much transport and save both time and fuel. There is to-day available a plethora of machinery to reduce donkey-work and aid production, but it comprises expensive pieces of plant. Yet we know of one quite small country jobbing foundry which has installed a Sandslinger fed by a Royer which fills boxes mounted on a large stripper. The whole is serviced by a few lengths of conveyor and all that is needed to attain near-perfection is a better system of sand control. However, there is a weight limit to this system, and for the largest jobs there must still be a choice between loam moulding, dry-sand moulding, sand slinging, and building up with oil-sand blocks and cores. The availability of skilled men usually determines the process used. Common to all, however, is the problem of raw-materials handling, both of metal and sand, and the proper preparation of the ladles and their manœuvring between furnace and mould. If there be anything upon which the Americans laid stress, it is in giving proper attention to every phase of manufacture of castings, and its correlation with earlier and later operations.

Conference Paper Author

MR. G. M. MICHIE, M.A., A.INST.P., A.I.M., Author of the Paper "Review of Present-day Steelfoundry Radiographic Practice," (printed opposite), is senior technical officer with the Research and Development Division of the British Steel Founders' Association. He was educated at the Royal Grammar School, Newcastle-on-Tyne and subsequently read for the Natural Science Tripos at Cambridge University where he graduated in 1939. After working for a period as a student apprentice in the metallurgical research laboratories of the British Thomson-Houston Company, he joined David Brown & Sons (Huddersfield), Limited., being appointed to the technical staff of the firm's steel and bronze foundries at Penistone. In addition to his metallurgical research experience during this period, Mr. Michie was for some considerable time responsible for the organisation of the firm's X-ray laboratories and other non-destructive testing services, and before leaving to join the B.S.F.A. in 1950, he held the appointment of senior research metallurgist at the Penistone Works. Mr. Michie has served on a number of committees dealing with non-destructive testing, including that of the Industrial Radiology Group of the Institute of Physics. Among papers which he had read, was one given to the Lancashire branch of the Institute of British Foundrymen in 1949 upon the subject of foundry radiography. Mr. Michie is an Associate of the Institute of Physics and the Institution of Metallurgists.

MR. G. M. MICHIE

Film Review

"Fork Lightening." This film was made for Conveyancer Fork Trucks, Limited, of Liverpool Road, Warrington, by Cinechrome, Limited, of Bournemouth. It is of the conventional type of industrial film, that is, there is a minimum of human interest sequences, a modicum of historical background, much stress on quality and inspection, the design and manufacturing department of the factory shown in some detail, and finally shots in the works of the users, showing modifications for special duties. The fork-lift truck being dynamic plant lends itself well to this sort of publicity and the ability to turn round within its own length would make even a London taxi driver gasp. The manœuvring of these trucks in restricted areas of busy machine-shops is outstanding. The reviewer has two adverse comments to make. The first is that during the showing of the laboratories, a young girl is operating a Vickers microscope, and it was stated she was examining a steel casting. The micrograph was shown, and the commentator then pointed out which was the graphite and which the phosphide eutectic! The second was the use of ordinary screwdrivers on an assembly line, whereas modern practice is to install power-driven tools. The unknown commentator was excellent, but possibly mechanical reproduction made him at times talk too quickly. Generally speaking, it reaches the high standard now to be expected from industrial films. It is available to organisations and works for private showing.

V. C. F.

Foundry Given Time to Abate Dust

Promise to Employ Consultant

Halesowen magistrates last Wednesday approved a suggestion that there should be a six-months adjournment of a case against Dudley & Dowell, of Compton Road, Cradley Heath, for failing to abate an alleged nuisance at their foundry in Olive Lane, Hill & Cakemore, Blackheath.

The case is believed to be the first prosecution of its kind in the Midlands, and attending as observers were representatives from the Corporations of Birmingham, Wolverhampton, Stourbridge and Walsall, and the Council of Willenhall, to hear the barristers, Mr. I. Sunderland for the Council and Mr. A. Holdsworth for Dudley & Dowell, argue the case.

Mr. A. Archer, sanitary inspector for the Halesowen Corporation, giving evidence of his recent inspection of the foundry, said he found that one of the ducts to the cyclones had collapsed, probably because of the coke boxes that the firm had fitted against his advice to abate the dust. He thought also that there had been a deterioration in the structure of the expansion chamber on one of the cupolas.

Lieut.-Col. R. V. C. Brook, a consulting engineer, in evidence, said that when he visited the foundry on October 29 some attempt had been made to deal with the nuisance, but it was not entirely satisfactory. With "reasonable" expenditure, from 75 to 80 per cent. of the dust could be eliminated from the cyclone outlets. From the cupolas it could be considerably reduced. Cross-examined, he agreed that the firm had attempted to improve on common practice for dealing with dust and dirt. There were bound to be teething troubles with apparatus for this purpose.

Mr. Holdsworth later submitted that there was no case to answer. The prosecution, he said, had failed to prove their authority to serve the summonses, or that it was their authority to issue the abatement notice.

The magistrates then decided there was a case and Mr. Holdsworth, who called no evidence, said that the firm had done as much already as an ordinary foundry and there was more they could do given reasonable time. His clients would be willing to employ Col. Brook and take his advice faithfully in dealing with the nuisance but it would take time and he asked for a substantial adjournment.

Mr. Sunderland said that complaints had been made by the local authority since July of last year. Mr. Archer and his assistants had done their utmost to urge the defendants into action and it was only in a last desperate attempt that the abatement notice had been served.

Captain W. E. J. Barlow (presiding) said the Bench leaned to the view that the time allowed had been inadequate since the issue of the notice. Those in industry knew that it was often a matter of trial and error in these matters, and an adjournment would be the best solution for both sides.

The magistrates then decided to adjourn the case for six months, on the assumption that proper steps would be taken to abate the nuisance.

Iron and Steel Engineers' Group

The sixteenth meeting of the Iron and Steel Engineers' Group will be held at 4, Grosvenor Gardens, London, S.W.1, on Tuesday, December 4. There will be the presentation and discussion of two Papers, "Cooling Beds for Bar Mills," by W. Udall (Brightside Foundry & Engineering Company, Limited), and "Some Comparisons between British and American Rolling Mill Practice," by G. Foster (Dorman, Long & Company, Limited).

Review of Present-day Steelfoundry Radiographic Practice*

By G. M. Michie, M.A., A.Inst.P., A.I.M.

After briefly tracing the history of industrial radiography, the Paper refers to some of the radiation sources now available to the industrial user. Attention is particularly directed towards the availability of artificially-prepared radioactive isotopes, which materials, together with X-rays, radium and radon are now in general use in many steel foundries. Consideration is given to the physical characteristics of each type of radiation source and to their respective merits in relation to radiographic practice.

Emphasis is placed upon the importance of fully recognising the care with which safety precautions must be observed in practice, reference being made to such considerations as protective enclosures, gamma-ray source containers, the tolerance dose, blood counts and other means of checking and preventing excessive radiation dosage. Safe working distances from various gamma-ray sources are diagrammatically indicated. The field of application of radiography in the steel foundry is then reviewed, reference being made to such problems as the interpretation of radiographs and the use of acceptance standards. In conclusion, the view is expressed that the more general application of radiographic methods now made possible through the availability of cheap radioactive isotopes, constitutes a major step towards the extended application of steel castings in many fields of engineering practice.

Introduction

As so often happens in the field of scientific achievement the discovery of X-rays and radium at the end of the last century was not followed by any notable industrial application for over twenty-five years. During this period, however, X-rays in the hands of physicists and chemists had begun to unravel the complex structure of matter, while at the same time popular imagination had been stirred by the penetrating properties of X-rays as witnessed by their extensive application in surgical practice, notably during the years of the first world war. It was not, however, until the 1920's that there was any serious attempt to employ for industrial or engineering purposes the technique of radiography which had become established in the medical world. Up till 1922, X-ray tubes had not in general been powerful enough to examine metallic materials except in thin sections, but in that year Coolidge in America developed the tube which now bears his name.

This discovery probably marks the birth of industrial radiography, since from that date it became possible to generate X-rays at 200,000 V., the penetrating power of which was sufficient to enable radiographs to be taken through some 2½ in. of steel. At this time, the possibility of employing the gamma radiation from radium seems to have been of little other than academic interest and the first record of its application to an engineering problem would appear to be in the work of two Frenchmen, Pilon and Laborde, who in 1925 used the radiation from one gramme of radium in an attempt to examine the interior of a marine steam turbine which was in place on a large passenger liner. As it happened they found it impossible to make any useful deductions from the resulting radiographs, but they can at least be credited with the production of what were probably the first industrial radiographs using gamma radiation.

By the year 1930 both techniques had been systematically studied both in this country and in the United States. In this country the development work was mainly carried out at Woolwich Arsenal, while in America extensive studies were conducted both at the Naval Research Laboratories in Washington and at the Watertown Arsenal. The Naval Research Laboratories were responsible for investigation of the radium technique, while the Watertown Arsenal Laboratories concentrated upon the application of X-ray methods. In the ten years immediately preceding the second world war, rapid advances were made in the application both of X-rays and radium to the inspection of castings and assemblies. Immediately prior to the war, probably not more than half-a-dozen steel foundries in this country had any experience whatsoever of industrial radiography, while not more than two had X-ray installations of their own. Along with other technical developments, the war years saw the rapid extension of radiographic technique as applied to the inspection of steel castings, and X-rays and radium became extensively employed in steel foundries, not only in order to comply with mandatory inspectional requirements, but also as a means of assisting in the improvement of general standards of casting soundness.

Thus, industrial radiographic practice was mainly founded upon the use of high-voltage X-rays and radium. Radon, which is the active product of the disintegration of radium, had also been employed, and there are records of the use on the Continent of another radioactive element, mesothorium. To the naturally-occurring radioactive elements are,

* Paper sponsored by the Research and Development Division of the British Steel Founders' Association and presented to the Annual Conference of the Institute of British Foundrymen.

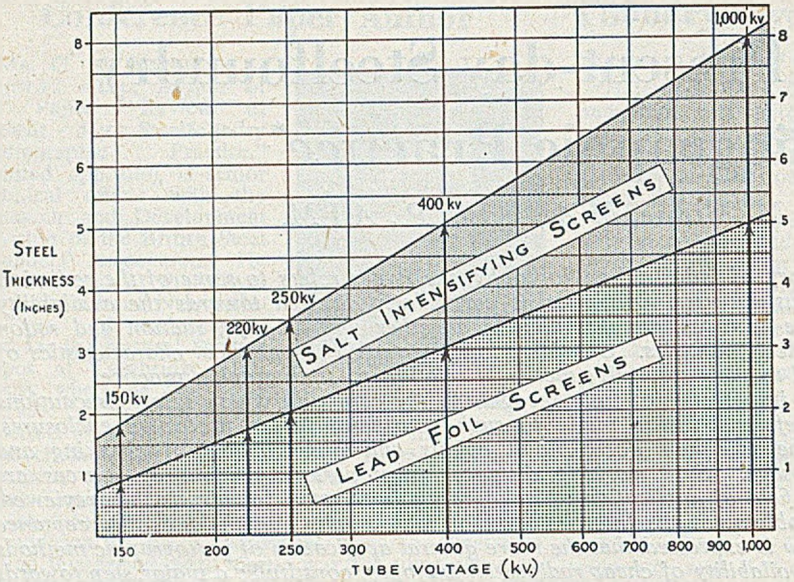


FIG. 1.—*Chart showing the Practical Thickness Limits which can be Radiographed at Various X-ray Tube Voltages.*

however, now added a whole series of artificially-prepared radioactive isotopes, a few of which are already finding extensive application for radiographic purposes in steel foundries and elsewhere.

X-rays and Gamma Rays

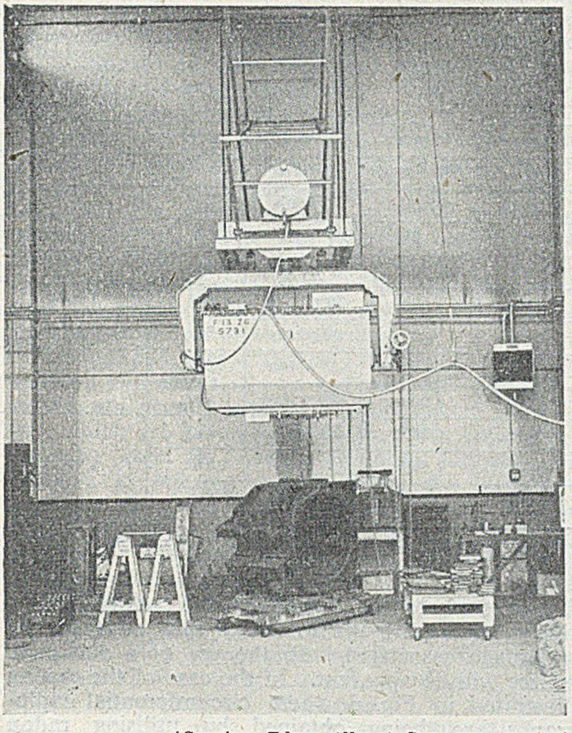
Radiography may be defined as the technique of recording on photographic film the shadow pattern formed by the passage of penetrating, ionizing radiations through opaque matter. This radiation may be obtained either from those radioactive materials whose spontaneous break-down is accompanied by the emission of gamma-rays, or from an X-ray tube which is energised by the application of a high electrical voltage. Both types of radiation are essentially similar in character, but whereas the radiation from an X-ray tube forms a continuous spectrum, the emission of gamma-rays is invariably in the form of a line spectrum in which the energy is concentrated in a number of isolated wavelengths. The gamma radiations from radium and radon have wavelengths which correspond to the minimum X-ray wavelengths generated at voltages between 200 and 2,000 kv., but owing to the much greater penetrating power of the shorter wavelengths, the gamma radiation from radium is effectively equivalent to X-rays generated by a tube operating at between 1,000 and 2,000 kv. Whereas, however, the penetrating power of an X-ray beam may be controlled by variation of tube voltage, no such control of the gamma radiation from radioactive sources is possible. Furthermore the duration of operation of an X-ray tube is accurately under the control of the operator, whereas the activity of radioactive material is continuous, being controlled by natural laws which cannot be influenced by the application of any known external force. Consequently the storage and handling of radioactive materials immediately set problems which do not arise in X-ray practice.

X-ray Apparatus

A number of firms now market X-ray apparatus designed for industrial as distinct from medical purposes. In the case of apparatus to be used for the inspection of steel castings, the requisite penetrating power is only obtained in plant operating at 200 kv. and upwards. This will be evident from Fig. 1, which provides a guide to the thicknesses of steel which may, under practical conditions, be radiographed using equipment operated at various voltages. The lower line indicates the limiting thicknesses employing a high sensitivity (lead screen) technique, while the upper line denotes the extended thickness range which is made possible by the use of a lower sensitivity (salt screen) technique. It should, however, be stated that, generally speaking, the upper line defines thickness limits which, owing to problems provided by scattered radiation, can only be radiographed with considerable difficulty and with appreciable loss of radiographic sensitivity. For the examination of casting sections in excess of 4 in. in thickness, X-ray tube voltages exceeding 400 kv. are really essential. A tube capable of operation at 750-1,000 kv. is, however, very costly, not only in itself but also owing to the size and special construction of the laboratory required to house it. No steel foundry in this country has been able to justify the expenditure involved in installing apparatus of this kind, especially in view of the availability of gamma-ray methods for the examination of thicker sections.

Several 40-kv. plants are, however, employed in steel foundries in this country and Fig. 2 illustrates one such apparatus in use. In this equipment the tube and high tension generator are contained within a single tank of oil, which is supported by an overhead pantograph. The control panel is in an adjoining room, and the set cannot be switched on until the operator has closed the heavy lead-lined door which separates the control and exposure rooms. Under favourable conditions such an apparatus is capable of producing radiographs through 5 in. of steel, but as has been observed, the more practical limit is in the neighbourhood of 4 in. For the examination of sections up to about 3 in., a number of foundries employ tubes energised at 220 or 250 kv. These generally differ from the one illustrated in Fig. 2, in that the tube and generators are usually separate, the high tension voltage being fed to the tube by means of specially insulated cables.

The capital cost of X-ray equipment, together with the attendant cost of suitably equipped laboratories, has always been a factor mitigating against the more widespread application of X-ray methods. Even in the case of a tube rated for operation at a maximum voltage of 250 kv., it is questionable



[*Courtesy Edgar Allen & Company, Limited*

FIG. 2.—400 *kv. X-ray Apparatus Installed in a Steelfoundry Laboratory.*

whether at the present time such apparatus could be purchased and a suitable laboratory erected, at a cost much below £5,000. In the case of 400-kv. apparatus the figure would more nearly approach £10,000, while for apparatus in the 1,000 kv. category, the total cost of the installation is more likely to be in the neighbourhood of £25,000.

Gamma-ray Sources

Until comparatively recently, practically all gamma radiography was conducted using either radium or radon, although as has been mentioned, mesothorium was used to some extent on the Continent. These elements are all present naturally in the earth's crust, but the lengthy and expensive processes which are required in order to extract them from the ores in which they occur, are reflected in the high prices which have to be paid for these materials.

To some extent this has had the effect of restricting their use, since a source of radium suitable for steelfoundry radiography used to cost between £1,200 and £3,000. In recent years the State has become the sole buyer of radium in this country and no outright purchase by individuals or firms is now possible. Sources suitable for radiographic purposes may, however, be hired from the Government-controlled radiochemical centre, at a rental based upon £225 per annum per 1,000 milligrammes. Radon, which is prepared by extraction from its parent radium, may be purchased outright from the Radiochemical Centre and is of little inherent value owing to its rapid decay which restricts its useful life to about a fortnight.

As a result of atomic-energy developments, it is now possible to prepare practically all elements in a radioactive state. This is achieved by neutron irradiation of the appropriate element in the atomic pile and usually, though not always, this results in the production of an unstable isotope of the parent element. In practice, the product consists mainly of the inactive parent element, together with a small concentration of one or more of its radioactive isotopes. The latter immediately commence to disintegrate at a rate characteristic of the isotope in question, a process which is accompanied by the emission of alpha, beta or gamma radiation. It will be appreciated that only those isotopes whose disintegration is accompanied by the emission of gamma radiation and whose rate of disintegration is not too rapid, are of any value for radiographic purposes. Thus, although it is possible to produce a radioactive isotope of gold (gold 198), which emits useful gamma radiation, this material decays so rapidly that it has lost half its strength in 2.7 days, and consequently is only of little interest for industrial radiographic purposes. (Since radioactive decay is an exponential process, it is convenient and customary to refer to the rate of decay in terms of the period required for an isotope to fall to half its original strength. Such a period is known as a " half life " of the isotope.)

Among the various radioactive isotopes which have been studied, three in particular have found application for industrial radiography. These are cobalt 60, tantalum 182, and iridium 192. Radiation from the first two of these may, for all practical purposes, be considered equivalent to the radiation from radium (and radon), radiographs taken using these sources being almost indistinguishable. On the other hand, radioactive iridium emits less penetrating radiation, the use of which results in radiographs showing greater contrast than would be observed with equivalent radium exposures. Iridium gamma radiation is in fact roughly equivalent to X-rays generated at 400-600 kv., and cannot therefore be used for the examination of the thicker sections of steel which are made possible using radium, cobalt or tantalum gamma radiation.

The three pile-made radioactive isotopes are normally supplied in the form of small cylinders, either 6 by 6 mm., 4 by 4 mm. or 2 by 2 mm. in size, and are enclosed in small aluminium-alloy capsules. The sources are activated by insertion within the atomic pile, the time necessary for each element to acquire a given strength being dependent both upon its nuclear properties and its physical size. Large sources respond more quickly than small ones, and iridium more quickly than cobalt. This is reflected in Table I which summarises some of the practical characteristics of both natural and artificial gamma-ray sources, and which also gives the prices charged for the preparation of these materials.

The emphasis which has been placed upon size of source will be referred to again in the next section, so that it will suffice here to state that adequate radiographic definition can in many instances only be obtained by the use of sources having a small

TABLE I.—*Gamma-ray Sources for Industrial Radiography.*

Source material.	Half life.	Special features.	Approximate source sizes, mm.	Strength, mCs.	Time to prepare.*	Cost of source.*	Approximate practical thickness limits for steel (inches).
Radium	1,600 yrs.	Long life	3 by 3	30 mgms.	8 weeks	£25†	1 to 4½
			5 by 5	250 mgms.	8 weeks	£56†	1 to 6
Radon	3.8 days	Short life, high intensity	1 by 1	1,000	1 week	£15	1 to 8
Cobalt 60	5.3 yrs.	Useful life, but takes a long time to prepare	2 by 2	20	20 months	£6	1 to 4½
			4 by 4	100	13 months	£14	1 to 5½
			6 by 6	500	30 months	£26	1 to 6
Tantalum 182 ..	120 days	Moderate life. Alternative to radium or cobalt	2 by 2	50	45 weeks	£5	1 to 4½
			4 by 4	500	35 weeks	£13	1 to 6
			6 by 6	1,000	30 weeks	£20	
Iridium 192 ..	70 days	High-intensity, low-energy radiation. Suitable only for thinner sections of steel	2 by 2	750	28 weeks	£15	½ to 2½
			4 by 4	1,000	6 weeks	£15	
			6 by 6	2,000	2 weeks	£18	

* Figures extracted from Catalogue No. 2, " Radioactive Materials and Stable Isotopes," Atomic Energy Research Establishment.
† Rental, per annum.

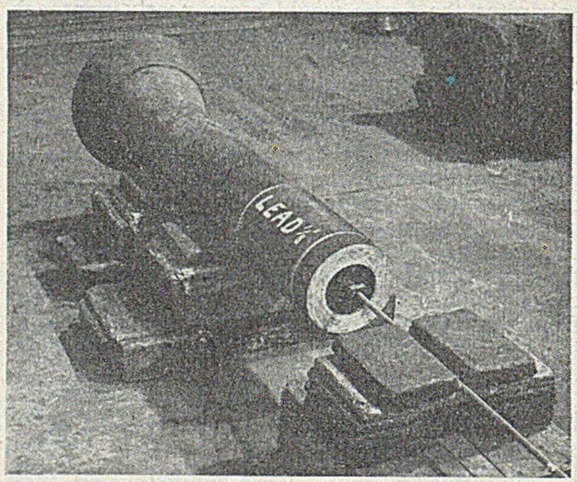
size. Unfortunately, the length of time required to irradiate a 2 by 2 mm. source of cobalt, for instance, effectively precludes its preparation except in sources of low strength. Thus while a 2 by 2 mm. source of cobalt irradiated for five years acquire a strength of 50 mCs., under the same pile conditions a source of iridium of the same size reaches a strength of 750 mCs. in a matter of 28 weeks. In the same period (28 weeks), a 4 by 4 mm. source of iridium would reach a strength of 4,000 mCs., which is too high to be safely handled without special precautions.

The use of radon, which has been referred to earlier, has definite advantages where a high intensity of gamma radiation is required from a small-size source. Radon gas is the active gamma-ray emitter contained within a source of radium, but sealed-off in the radium capsule it is dispersed throughout the mass of the radium, where it occupies a relatively large volume. By extraction from its parent radium, the radon may be made to occupy a volume some 50 times less, which factor may be increased to approximately 5,000 by absorbing the gas on to a grain of activated charcoal.

Radiographic Technique

While it is not proposed in this Paper to discuss in detail the many aspects of radiographic technique that are the special concern of the industrial radiologist, nevertheless certain general principles must be referred to. In the first place it is important to emphasise that a radiograph, whether produced by X-rays or gamma-rays, must not be confused with a photograph in the ordinary sense. No lens is employed in the production of a radiograph, the preparation of which depends upon the simple shadow principle. In consequence, the formation of a sharp radiographic image of a casting flaw demands among other things the observation of those elementary geometric principles which control the " blurring " of ordinary shadows. Thus in instances where the geometry of the casting is effective in restricting the source to film distance, the advantage associated with the use of a small-size source will be apparent. In the case of the casting illustrated in Fig. 3 where circumferential radiographs are being obtained by utilising radon placed on the axis of a cast-steel cylinder, it would be impossible to obtain adequate definition except by the use of a small source which has an effective size of approximately 1 by 1 mm.

While the usual means of recording the radiographic shadow is of course to expose it upon a double-coated photographic film, the method known



[Courtesy Edgar Allen & Company, Limited

FIG. 3.—*Radiographing a Cast-steel Cylinder using Radon. After Positioning of the Films, the Source (held on the end of a Handling Rod) is placed on the Axis of the Cylinder at the Centre of the Belt of Films which are Backed by Lead Sheeting. This Technique can only be Satisfactorily Applied when a Source of Small Size is Available.*

as "screening" or "fluoroscopy" must be referred to in passing. In this method the X-ray shadow is allowed to fall on a fluorescent screen, which partially transforms the invisible X-radiation into visible light of a greenish colour. This screen may then be viewed through a window of protective lead glass and interpretation of the shadow made without the necessity of recording the image photographically. The method has been extensively employed for the inspection of small light-alloy castings, but its relative insensitivity, together with the fact that much more penetrating radiation would have to be employed for the examination of steel, has precluded its general adoption as a method for the inspection of steel castings.

Radiographic film is normally exposed sandwiched between two sheets known as "screens." The best results are usually obtained using screens of lead foil, which are generally 0.005 in. thick, since these not only exert an intensifying action but are also effective in filtering out much of the unwanted scattered radiation which inevitably arises during exposure. A much more powerful intensifying action is however obtained by using screens coated with a fluorescent chemical, which, from a practical point of view, permit exposures to be made more rapidly, and also enables thicker sections to be examined in a given exposure time. This difference is diagrammatically depicted in Fig. 1, which shows the practical thickness limits which may be radiographed at various tube voltages, using both lead-foil screens and salt intensifying screens. It will be noted that, roughly speaking, the use of salt intensifying screens increases by 50 per cent. the limiting thicknesses which may be examined with a given X-ray apparatus. The same remarks do not apply with equal force to radiography using gamma radiation. Owing to the far lower intensity of gamma-rays, the response of salt intensifying screens is considerably less marked and in most cases the small decrease in exposure time made possible, is more than offset by the inferior quality of the resulting radiograph.

Exposure times, it will be appreciated, are usually measured in minutes in X-ray work and in hours in gamma-ray work. This is again due to the relatively low intensity of radiation emitted from gamma-ray sources as compared with the emission of an X-ray tube, but in practice is less of a disadvantage than might at first be apparent. Once prepared, gamma-ray exposures require no attention whatsoever until it is time to remove the films for development, a feature often taken advantage of by employing overnight periods for exposure purposes. Furthermore, by virtue of the fact that gamma-ray sources permit "all-round" exposure, the simultaneous examination of a number of castings is possible, so that the actual exposure time per casting may be relatively low. The question of exposure time per casting is also influenced by the number of radiographs required to give coverage of the castings in question. In general, owing to the less penetrating nature of X-radiation from tubes other than those operated at very high voltages (1,000 and 2,000 kv.), a larger number of X-ray exposures as compared with gamma-ray exposures are necessary in order to produce comparable coverage in any given instance. This feature provides another reason why gamma-ray radiography is in general a more satisfactory method for the inspection of steel castings.

One important aspect of gamma-ray technique which considerably simplifies the radiographic procedure, is the relatively small amount of scattered radiation which arises during exposure. In X-ray exposures of steel above one inch in thickness, most elaborate precautions have frequently to be taken in order to prevent the film from becoming badly fogged by radiation arising both within the specimen and by scattering from surrounding objects. Lead masks have frequently to be cut to meet the

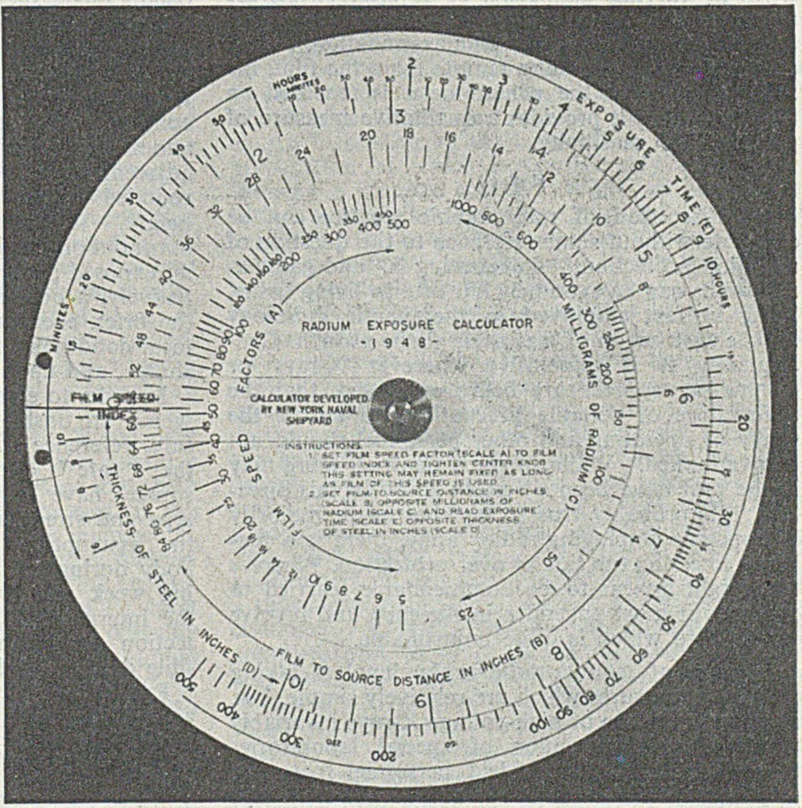


FIG. 4.—*Radium Exposure Calculator as Developed by the United States Naval Research Laboratories and Issued by the Radium Chemical Company, Inc.*

Steelfoundry Radiographic Practice.

profile of the casting, cored holes blocked with radiographically-opaque putty, or if the casting is small, it may be immersed in a special solution. Expedients of this nature are rarely necessary in gamma-ray radiography, and although the problem is still present, the precautions which have to be taken are relatively simple.

The problem of estimation of the correct exposure time for various thicknesses of steel is generally met by the use of exposure charts or calculators. In X-ray work this estimation is usually made from a simple chart which relates steel thickness to exposure time at various different tube voltage settings, but at a fixed tube to film distance. Corrections for other working distances can readily be made by application of the inverse square law. Although charts are also employed in gamma-ray work, the use of specially prepared slide rules or circular calculators is generally more convenient. One such calculator is illustrated in Fig. 4.

In order to provide indication in any given instance that adequate penetration of the part under examination has been secured, it is frequent, and should be standard, practice to employ what are known as *penetrameters* (or penetration gauges). These generally consist, either of a series of steel wires of varying diameters, or of steel strips, the thicknesses of which form a definite percentage of the sections under radiographic examination. Placed on the side of the casting remote from the film, the shadow image of the penetrameter is recorded on the film where it provides a qualitative measure of radiographic sensitivity.

Safety

No discussion of radiographic practice can be complete without some reference to the question of radiation protection. Penetrating X- and gamma-radiations can be extremely harmful to living tissue, being in fact employed in therapeutic radiology for the destruction of malignant tissue growth. Consequently it is imperative wherever X-rays or gamma-ray sources are being employed, that the observation of suitable precautions to ensure the safety of operating and other personnel should not be overlooked. While in some quarters there may in the past have been a certain laxity in this direction, it is probably true to say that in the majority of concerns employing radiography, there is a tendency to err on the side of over-protection. Whereas this might appear to be commendable, carried to extremes it must engender inefficiency and involve expenditure which is quite unjustifiable.

The use of gamma-radiography involves taking protective measures which are relatively simple, but, in contrast, the use of high-voltage X-rays invariably requires the construction of special laboratories which are designed to shield personnel from the very high intensities of X-radiation. While X-rays generated in the low and medium voltage range (100-400 kv.) are not as penetrating as the radiation from the usual gamma-ray sources employed for radiographic purposes, the intensity or quantity of radiation is invariably many thousands of times greater, a fact largely responsible for the shorter exposure time previously noted. Consequently if personnel are to be employed within a reasonable distance of an energised X-ray tube, they must be shielded from the radiation by a suitable protective barrier. Such a barrier usually consists of a lead-lined wall, or alternatively one constructed of barium sulphate composition brick, the thickness of which will depend upon the voltage rating of the tube in question. Not only must the apparatus be controlled from a point behind the barrier, but precautions must be taken to prevent anyone from entering the exposure area while the tube is in operation. This usually involves the provision of doors with limit switches interlocking with the X-ray control circuits, audible warning signals and suitably-illuminated danger notices.

Elaborate precautionary measures are fortunately unnecessary in gamma-ray work. The intensity of the radiation is relatively so low that the danger zone is confined to the area immediately surrounding an exposed source, the actual safety distance depending upon the source in use and its intensity at the time of exposure. In consequence the erection of absorbing barriers is less likely to be necessary than when using X-rays, except in cases where the amount of available floor space is limited. In conducting "site radiography", it is usually sufficient to rope off the appropriate area, entry to which is discouraged by the display of suitably-worded notices. On the other hand, in foundries where radiography is employed for routine process control and inspection, it is obviously better to allocate a specific site for this work, which, if adjacent to other working areas, should be surrounded by an ordinary brick wall of requisite height. Within this area it may be advisable to mark out on the floor a boundary line, outside which an exposed source should not be employed. Alternatively, a boundary fence may be erected around the brick enclosure, at a distance dependent upon local conditions, upon the strength and type of the source, and upon the wall thickness.

In order to give some idea of the distance beyond which an unshielded source may be regarded as safe, reference should be made to Fig. 5 in which the "safe" distances from various radioactive sources have been plotted as a function of source type and strength. The chart is based upon:—(*a*) the assumption of continuous exposure of the body during the whole of a nominal 40-hr. working week and (*b*) the latest recommendations of the International Commission of Radiological Protection concerning the weekly maximum permissible dose or "tolerance dose."

Provided that all workers other than those actually engaged upon radiographic duties are kept outside the areas defined by the distances indicated in Fig. 5, no radiation danger to such personnel exists. In the case of radiographic personnel the position is somewhat different, since the necessity for approaching exposed sources at closer range cannot be avoided. Consequently such periods

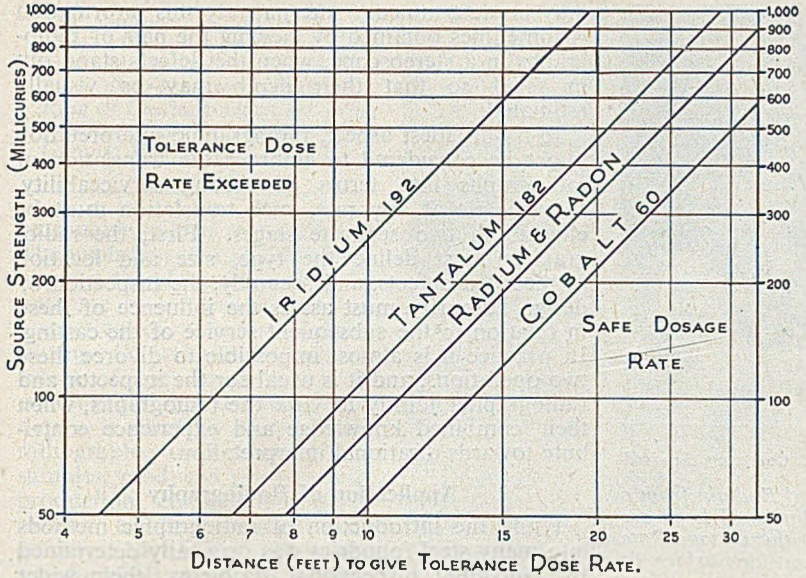


FIG. 5.—*Chart Indicating the Tolerance-dose-rate Distances from Various Radioactive Sources. The Values are Based upon the Assumption of Continuous Exposure of the Body during a 40-hr. Working Week.*

during which the dose rate must necessarily be high, must be compensated for by periods during which the dose rate is low, so ensuring that the total weekly dose does not exceed the maximum permissible value. In practice this is achieved by having the exposure area remote from the darkroom or other premises occupied by radiographic personnel. As a means of ensuring that operators do not receive more than the stipulated weekly tolerance dose, reference should be made to the film monitoring service provided by the National Physical Laboratory, in which small badge-size films are supplied for carrying on the person. After wearing for a suitable period of time, these are returned to the N.P.L. for measurement of the integrated dose of gamma-radiation, when a report is issued to the establishment concerned. Alternatively, several firms market small pocket ionisation chamber dosimeters which likewise record the total dose of gamma-rays received, but which provide greater protection than afforded by the film badge, since no time delay is involved before the dose received can be estimated.

It has long been recognised that the blood cells produced by the bone marrow are highly sensitive to X- and gamma-rays and overdosage by these radiations is quickly reflected by changes in the blood constitution detectable under the microscope. This feature therefore provides yet another method of detecting radiation dosage, and forms in fact the basis of the accepted method of checking upon the health of workers in this field. It is officially recommended that radiographic personnel should be systematically submitted to blood tests under the supervision of a qualified hæmatologist, such tests being carried out both prior to employment upon radiographic duties, and subsequently at three monthly intervals. In this connection mention should be made of the service provided by H.M. Medical Inspectorate of Factories, whereby arrangements are made for the periodic attendance of an expert hæmatologist at the works of any concern employing radiographic methods.

One of the most important safety measures which must be considered by concerns employing gamma radiography, is the choice of radioactive source containers. Such containers fall into two categories:—(*a*) Those designed for storage of the sources and from which the latter are withdrawn as and when required for exposure purposes, and (*b*) those designed for storage and transport, and from which the source need not always be removed for exposure purposes. In such containers, however, provision is invariably made for removing the source upon occasions when the radiographic technique requires the use of "all-round" exposure.

Fig. 6 illustrates a container or "safe" of the first type, an operator being shown removing a source on the end of a handling rod. The safe is located on the exposure site, so that only a matter of seconds should be required to position the source in relation to the casting/film assembly, the preparation of which is considerably assisted by utilising a dummy source. While setting up the active source the operator must of course be exposed to a dosage rate considerably higher than would be safe for lengthy periods, but this should be compensated for by periods when the dose rate is low, either because the source is in storage or because the radiographer conducts his other duties on a site removed from the exposure area.

With regard to containers falling in the second category these are necessarily more elaborate in design and their construction beyond the means of the majority of steel foundries. Several excellent models are now marketed, one of which is illustrated in Fig. 7. In this model a high gamma-ray absorption is secured by the use of a heavy tungsten alloy, which material, having a density approximately 50 per cent. greater than lead, permits a substantial reduction in the size and weight of the container. It must, however, be understood that complete absorption of penetrating gamma radiation cannot be achieved except by the use of such thickness of the absorbing material that the container would be too heavy to be carried. Consequently, all such containers must represent a compromise between portability and 100 per cent. protection, which again is best achieved by the introduction of a distance factor. This demands that the surface of the container should not be brought

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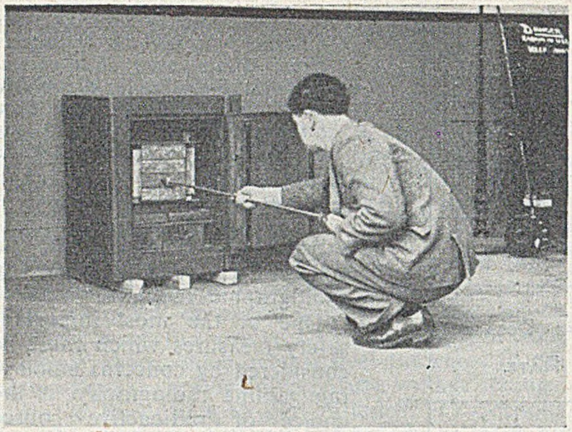


[Courtesy *Edgar Allen & Company, Limited*

FIG. 6.—*Operator removing a Source of Radium from a Storage Safe. In this instance, Blocks of Lead are employed as a means of reducing the Dosage Rate to a non-harmful level on the outside surface of the Safe.*

into close proximity to the body, and therefore by the provision of a T-shaped carrying handle of sufficient length, the necessity for handling the surface of the container is avoided. The container may be carried between two persons using a bar threaded through the hollow crosspiece of the carrying handle.

As illustrated, the source is being withdrawn on the end of a handling rod which has an arrangement for bringing the source holder into the upright position often found convenient. Alternatively, by turning the carrying handle through 180 deg., the source may be rotated into a position from which a directional beam is obtained, when the carrying handle becomes detached, so preventing accidental carriage of the container at a time when the source is unshielded.

Interpretation of Radiographs

It must be emphasised that the ability of a radiograph to record a casting defect is dependent upon the differential absorption of the radiation by metal of varying thickness or density. In consequence, only those defects which constitute either voids or material of different density from the containing metal will give rise to radiographic images, and for this reason the detection by radiographic means of fine cracks or "laps" will only occur in those cases where these happen to fall more or less parallel to the incident radiation. Shrinkage cavities, hot tears, sand and slag inclusions, blowholes and gas pockets are all normally detectable, and as would be expected, their shadow images are of characteristic outline. Whereas their depth below the casting surface is normally inferred from a knowledge of their mode of formation, this information may also be obtained radiographically by taking shots at two different angles. By virtue of the parallax effect, the images of defects are displaced in relation to the images of lead markers placed on the casting surface, and by a simple calculation, the depth of the defects may be determined. Alternatively this information is sometimes obtained by viewing the pair of radiographs in a stereoscope, when the defects stand out in relief so that their depth may be visually estimated.

In its broadest aspect, radiographic interpretation might be considered to embrace the translation of radiographs into terms of casting serviceability. In principle at any rate, such translation must be effected in two separate stages. First, the radiographer must define the type, size and location of recorded defects, and secondly, the inspection or design authority must assess the influence of these in relation to the subsequent service of the casting. In practice it is almost impossible to divorce these two operations, and it is usual for the inspector and radiographer jointly to view the radiographs, when their combined knowledge and experience contribute towards a rational interpretation.

Application of Radiography

While the introduction of radiographic methods into many steel foundries was originally determined by individual inspectional problems, their wider field of application emerged only as a result of experience, often won in the face of adverse criticism and even active opposition. Such criticism or opposition was mainly due to an incomplete understanding of the role which radiographic inspection should play in the general advancement of foundry technique. Naturally the manner in which radiography is applied by individual foundries depends to some extent upon the number and type of castings to be produced, but generally speaking, its application will be found to fall under one or other of the following headings:—

(*a*) *Sample approval.*

Those foundries which undertake repetition work are naturally faced with the problem of ensuring that for any particular pattern they have evolved a running and feeding technique, which not only produces a satisfactory casting, but does so at a

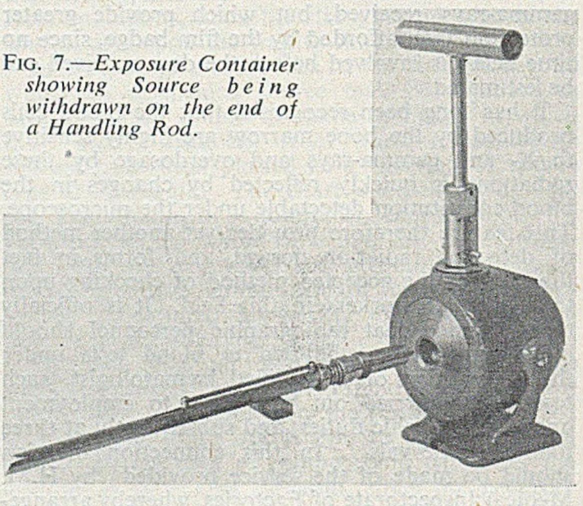
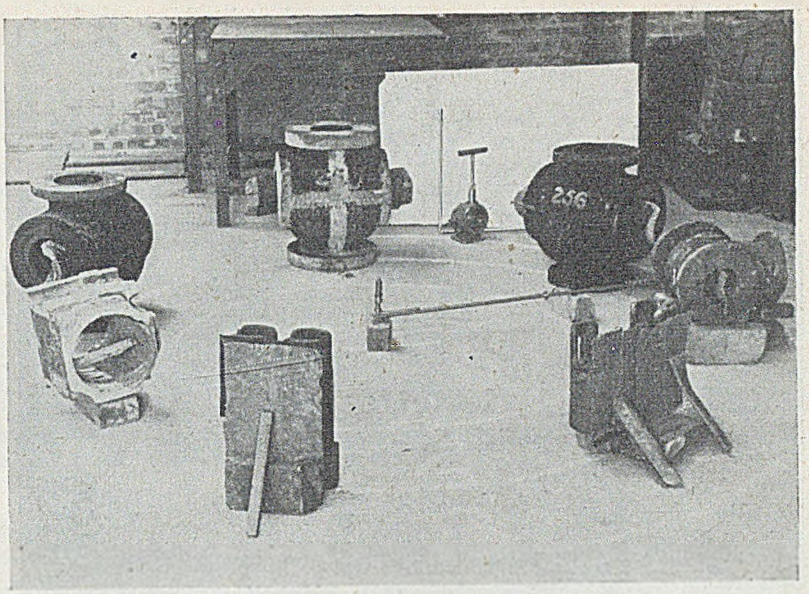


FIG. 7.—*Exposure Container showing Source being withdrawn on the end of a Handling Rod.*

[Courtesy *Solus Schall, Limited*

FIG. 8.—"*Operation Stonehenge.*" *The Radioactive Source, having been withdrawn from the Container illustrated in Fig. 7, has been placed in the centre of a Ring of Castings which are being simultaneously exposed to the Gamma Radiation.*



[*Courtesy Lake & Elliott, Limited*

reasonable yield of metal poured. The evolution of a suitable technique is therefore frequently the outcome of the production and inspection of a series of pilot castings in which the precise effect of each modification to running, gating and feeding techniques is carefully noted. The radiographic inspection of such samples, produced prior to bulk production, enables this information to be obtained both quickly and without the necessity for destructive tests. Radiography thus supersedes the older method in which castings were either sectioned or broken up to disclose any hidden shrinkage cavities. Whereas this probably remains the quickest and cheapest method of sample inspection of small light alloy castings, such is certainly not the case with steel castings which are more difficult to section adequately, and in any case have a relatively low scrap value. Consequently this application of radiography must be regarded as one of the most valuable in the steel foundry, where it constitutes a method of inspection applied by the founder for the purpose of proving and improving his technique, both in relation to quality of casting and economy of production.

(*b*) *Final inspection by the founder of important production-line castings.*

In addition to the use of radiography in sample or pilot casting approval, it is obvious that the founder often wishes to inform himself upon the soundness or otherwise of castings of special importance. In particular, one may quote the instance of large castings upon which extensive machining operations are to be performed and which, by virtue of service requirements, demand freedom from blemishes on highly finished working surfaces. With such castings the disclosure of hidden casting defects during the final stages of machining may not only involve the scrapping of the casting, but the wastage of valuable machine-tool time. The disclosure by radiography of such defects before the casting reaches the machine shops will therefore serve two valuable purposes:—

(i) The avoidance of expensive machining operations on defective castings.

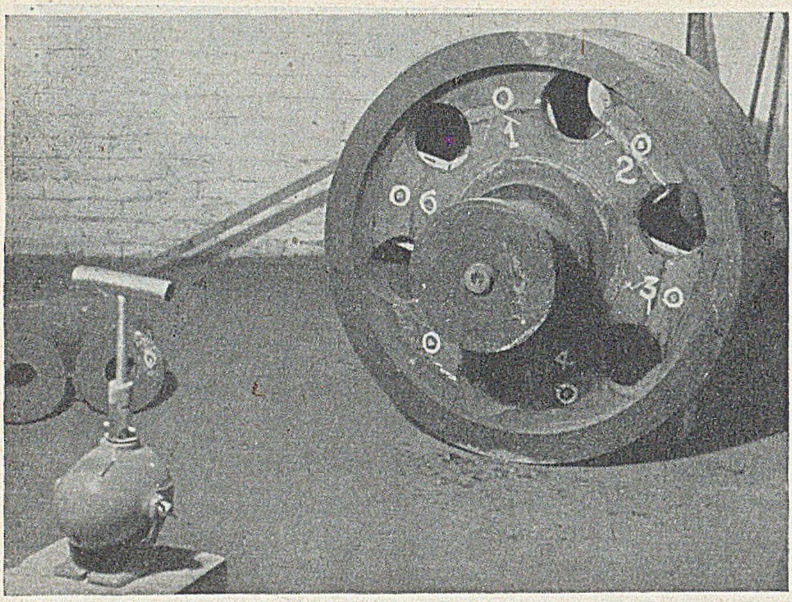
(ii) The provision of information on the presence of defects at a time when it may be possible to undertake welding repairs. In such instances, the location of the defects may be marked out by the radiographer and subsequently excavated by means of a pneumatic chisel. The resulting cavity may then be filled by electric arc welding, the casting annealed or stress-relieved, and if necessary the weld deposit radiographed to prove its soundness.

In applications falling under this heading, it should be appreciated that 100 per cent. examination of the castings is not necessarily implied. The decision regarding the degree of radiographic inspection remains of course in the hands of the founder, who may decide to examine either a percentage of the castings completely, or alternatively, each casting partially, *i.e.*, only in such critical areas as might, for design reasons, be subject to local casting defects, or which, in later service, may be subject to high operating stresses.

(*c*) *Final inspection as a purchaser's specification requirement.*

Radiographic inspection is frequently called for as a condition of the purchaser's contract, either as a separate clause or by virtue of a material specification (*e.g.*, D.T.D.666 and 705). In such instances the radiographs, along with other test data, may be considered as a basis for acceptance or rejection of the castings by the customer or his representative. The cost of radiography, together with the increased production costs consequent upon the higher standard of soundness implied by the radiographic requirements, are, of course, legitimately chargeable to the purchaser of the castings. Radiographic inspection conducted under this heading obviously demands that the production of castings should not be undertaken until some basis of agreement is reached between founder and purchaser as to the standard of internal soundness demanded by the application in question.

It will readily be appreciated therefore that the imposition of radiographic tests as a final inspection requirement places considerable responsibility upon individual inspectors, and the potential



[Courtesy Jarrow Metal Industries, Limited

FIG. 9.—*This Gear has been fabricated by welding together Two Steel Castings. An Exposure-type Container is shown in position for Radiographing the Welded Joints between Rim and Wheel Centre.*

need for some form of radiographic acceptance standards will be apparent. Such standards have in fact been adopted in the United States, where years ago the American navy department issued a set of radiographs illustrating different types and degrees of defects met with in steel castings. These reference radiographs were issued in conjunction with tables which set out the permissible defects in castings intended for various types of service. These standards relate, of course, to American naval practice and are not therefore directly applicable to castings used outside this field. As reference radiographs, however, they may prove valuable and with this purpose in mind have in fact been adopted by the American Society for Testing Materials (A.S.T.M.: E1-47T).

In this country, no attempt has been made to formulate specific radiographic acceptance standards for castings, but the principle is recognised by the majority of inspecting authorities. For instance, the A.I.D. require radiographic inspection of all stressed aircraft castings, and the Admiralty has included a radiographic clause in their specification for all carbon molybdenum steel castings for operation at temperatures in excess of 750 deg. F. (400 deg. C.).

Conclusions

The fact that steel castings are now employed as important aircraft parts subject to high dynamic stresses during flight and designed to factors of safety directly comparable with those applied to wrought-steel components performing similar duties, is an obvious indication of the development of the steel casting as a reliable structural unit. The attainment of the high level of quality and dependability which have made such application possible has in no small measure been due to the availability of non-destructive testing methods, of which radiography undoubtedly ranks among the most important. Furthermore, by employing radiography, not only have steel founders been assisted in their task of improving general standards of casting soundness, but both engineers and foundrymen have had at their disposal a means of inspection, the rational use of which has permitted the application of steel castings in fields hitherto dominated by wrought steel.

The more recent general adoption of radiography as a routine inspection method has in many cases been a direct result of the availability of cheap radioactive isotopes, which materials appeared on the British market approximately two years ago. The benefit which the industry as a whole is likely to reap from developments of this kind is obviously dependent upon a wide understanding of the established or potential role which each can play in the scheme of foundry inspection. It is with this in mind that the Research and Development Division of the British Steel Founders' Association attaches particular importance to all developments in radiographic technique and to their application in practice. Not only do all industrial aspects of the subject come under the survey of the Division's appropriate Committees, but it is the responsibility of the Division's permanent staff to ensure that the steel foundry industry is at all time informed of current developments and provided with essential operating data.

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DISCUSSION

MR. JOHNSON congratulated Mr. Michie on the excellence of his Paper and said that a pleasing aspect was that it provided tangible evidence of the co-operation between the British Steel Founders' Association and the Institute, which co-operation was very necessary for the general good of the foundry industry as a whole. The Paper could be used as a work of reference by foundries who contemplated putting these radio-isotopes into use as well as by foundries—particularly steel foundries—who were already making use of radiography. He appreciated that fact that the Author had covered a very wide field and that inevitably some items must be overlooked, but he felt it was a pity that in Table I in the Paper Mr. Michie had not attempted to add the exposure ranges for the different strength of sources given, That was his only criticism.

MR. MICHIE agreed that in Table I it might have been desirable to indicate the approximate exposure times for the various sources and thicknesses quoted. The difficulty really lay in the fact that the exposure time must in each case be determined by the source-to-film distance chosen for the application in question. This was bound to vary according to circumstances, so that in applications where a short source-to-film distance was permissible, the exposure times could be considerably shorter than would otherwise be the case. Short source-to-film distances might generally be associated with low sensitivity, but if one was prepared to accept this limitation, it would be possible to radiograph sections appreciably thicker than those indicated in Table I. To quote an example one might refer to the thickness limit of 8 in. given in Table I against a 1,000mCs source of radon. If, however, only relatively large shrinkage cavities were sought, it would possibly be feasible to radiograph as much as 11 in. of steel, by placing the radon source against one surface of the specimen. The definition obtained would then be adequate for the half section adjacent to the film; the other half section could then be covered by reversing the relative positions of source and film. Exposures of this type would of course suffer from the drawback that only a relatively small volume of the casting would be covered by each pair of radiographs, and it was therefore to be appreciated that even using a powerful radon source, the inspection of large areas of such thickness could not be regarded as a practical proposition.

MR. RANKIN (Kelvin & Hughes (Industrial) Limited) said probably the most important method of application of radiography was, as Mr. Michie had pointed out, that of using it as a development tool. In that connection he would refer members to a Paper by Dr. Jackson which had appeared in the *Proceedings* of the Iron and Steel Institute about 1947 and which had dealt with that aspect in a most effective manner.

Light Alloys and Isotopes

MR. LEES said he had nothing at all to do with steel but he had one or two questions on the possibility of using radioactive isotopes in the radiography of materials other than steel. He was thinking particularly of aluminium; a great number of aluminium castings had been subject to X-ray inspection of a stringent nature. With aluminium it was possible to get radiographs with quite low-power X-ray tubes, and he wondered whether there was any use in trying radioactive isotopes instead, as on the face of it one might think that the cost of the equipment would be very much lower.

Secondly, he mentioned that in X-ray radiography on aluminium castings it had occasionally been found that there was a mottled appearance in the prints, and that had at first been regarded as some kind of fine porosity and in some quarters it had led to the rejection of the castings. It had turned out, however, that it was really a reflection of the macro-structure of the casting. In fact, from the outset the prints had very much the appearance of a macro-structure with a rather coarse grain size. It was shown that, in passing through an inch or so of aluminium, the X-rays from the tube became increasingly monochromatic, and after being so filtered it was possible to get some kind of extinction effect, thus creating in grains of suitable orientation a darkening and in others the more normal appearance. He would be interested to know whether anything of the kind had been observed with steel castings.

MR. MICHIE said, as far as he knew, there had been very little work done in this country upon the use of isotopes for the radiographic examination of castings in materials other than steel and copper-base alloys, but he would be surprised if, among the isotopes now becoming available from Harwell, some were not in due course found suitable for the examination of light alloys. In America attempts had been made to use one of the isotopes of selenium.

Mottling

Referring to Mr. Lees's second point concerning the mottling sometimes experienced in the radiographs of light-alloy castings, he could confirm that the effect was not confined to the radiographs of these materials. The phenomenon was also commonly experienced in the X-ray radiography of high-alloy stainless or heat-resisting steel castings, where its occurrence was associated with the austenitic grain structure of the material. It was generally believed to be due to the superimposition of a number of Laue diffraction patterns, each of which is formed by the passage of the radiation through a single grain of metal. The effect might be expected to occur in any metal of essentially single-phase constitution where the grain size was relatively coarse. No suitable means of overcoming this somewhat distracting phenomenon had been discovered. Its intensity could be reduced by increasing the voltage applied to the X-ray tube, but this was accompanied by reduced radiographic contrast with attendant loss in flaw visibility.

Limitations

MR. CLARY said he wished to point out to the Author one of the serious drawbacks and disappointments in radiographic inspection, and that was its inability to detect, or estimate the seriousness of, internal cracks. Such cracks might have a very large area in one plane and yet have microscopic thickness, and it had seemed to them in the past that, unless they were extremely fortunate and got the main axis of the body of the rays parallel with such a crack, it was missed altogether, and he would like to know whether there had been any improvement recently.

MR. MICHIE fully appreciated the limitations of the radiographic method and said he would never suggest that the method was capable of detecting every form of structural defect in a casting. An X-ray apparatus was certainly not an ideal tool for the

Steelfoundry Radiographic Practice—Discussion

detection of internal cracks, which defects presented a difficult problem for any inspectional method. The ultrasonic technique presented considerable attraction from this point of view, but it was unfortunate that casting surfaces and profiles did not normally permit the application of this method. He thought that possibly Mr. Rankin might like to add something on this subject.

Ultrasonic Testing

MR. RANKIN enquired what sort of castings were concerned, to which MR. CLARY replied that he had in mind cast crankshafts; in some cases these might have internal cracks which occurred, of course, on cooling.

MR. RANKIN said he did not know whether Mr. Clary was aware of the transverse-wave mode charger methods of ultrasonic apparatus, but some of those might do the job. It was then possible to get the energy in the proper direction although the end surface was not available, and that technique had, for example, been applied very successfully for the detection of particular types of cracks which had been a problem for some considerable time due to the unsuitability of radiography for detecting them.

Measuring Radiation Density

Returning to Mr. Michie's Paper he wished to ask the Author whether he would amplify his remarks in connection with the use of geiger-counters and other devices for measuring density of radiation. He had just been reading a Paper by Mr. Wiltshire, published in 1939 by the Institute of Electrical Engineers, in which that point had been stressed in the words:—" I think that ionisation methods may ultimately prove, in certain cases, a help towards the solution of the problem of determining what loss of metal there is." There had been much work on the Continent on the subject, but as far as he knew, it was with comparatively little success.

Alternatives to Photography

MR. MICHIE replied that he had no detailed information regarding developments in that direction but he could give his own views as to the potential value of such methods. He thought it must always be recognised that part of the value of radiography was that it provided a picture of the defects which were disclosed. It was of very great value to the foundryman to be able to see a picture of any defects reported and the value of a method which, even to the relatively inexperienced eye, disclosed the severity and shape of defects, could not be overemphasised. One of the principal disadvantages of the ultrasonic technique was undoubtedly its inability to give very much idea of the type of defect disclosed. The same criticism would, of course, apply in using a technique such as that to which Mr. Rankin had referred, where instead of recording the X-ray shadow pattern by means of photographic film, one explored the surface by means of a counter which would detect the intensity of the transmitted radiation. Where such a method would undoubtedly have considerable application would be in the rapid exploration of fairly large castings. They might take, for instance, the casting illustrated in Fig. 9, where it might be desirable to examine the rim of the wheel for freedom from internal flaws. To radiograph such a large area completely would be a lengthy and costly operation. On the other hand if a technique could be devised whereby the rim was made to rotate slowly between either an X-ray tube or isotope source and a suitable counter tube, it might only be necessary to radiograph those sections in which the counter indicated the presence of an internal discontinuity. For such special applications he had no doubt methods would be developed, but he questioned whether they were likely to compete with radiography as a means of general castings inspection.

Differing Requirements of Billet and Casting

MR. LEES said in one light-alloy extrusion plant at least, the cast billets were regularly scanned by the ultrasonic method.

MR. MICHIE agreed with Mr. Lees that there were a number of instances in which the ultrasonic method had been employed with considerable success, but was it not the case that in the instances quoted this method had been used because of the lack of availability of a better method of inspection? Unfortunately, the stage had not yet been reached in the steel foundry when castings entirely free from defects could be produced, and consequently the inspectional problem lay in assessing the significance of any flaws which were revealed. Therein lay the special virtue of radiographic inspection.

MR. LEES remarked that Mr. Michie was quite correct; previously there had been no means of inspection of the billets and the defects only appeared during extrusion.

MR. RANKIN said that part of his worry regarding that subject was the fact that there was a movement to attempt to obtain pictorial representations of ultrasonic test results, and, in a way, that was rather unfortunate because one could not easily create an analogy between the two methods, and the pictorial representations which were possible with the ultrasonic method were not necessarily so efficient as the radiographic method. However, while it was clear (and he agreed very fully) that at the present time the best method of inspection was to obtain a pictorial representation by radiography on steel castings, it was surely because their knowledge of the strength of materials as related to the special characteristics of flaws was inadequate. When one had a three-dimensional picture of a casting it was necessary to accept or reject that casting on the basis of human experience, and at the moment there was no short cut. He agreed with Mr. Michie that until the ultrasonic readings could be directly related to strength the pictorial method was an essential feature, but rather felt that an alternative should be diligently sought.

Balanced Cores in Production Moulding

By F. H. Wakeham

An application and method of preventing misplacement of balanced cores in production moulding is described in what follows: The section of a casting is shown in Fig. 1 (*a*) which has a circular boss on the outside and is thickened on the inside by a "D" shaped boss. A considerable quantity of this casting was required and it was deemed essential that two patterns should be turned in halves, being connected by means of the core-print, which was turned along with the patterns. The bosses were in this way sunk into the body of the patterns so eliminating "feather edges" on the fillet, at the junction of the boss and body of the pattern.

The two halves were accurately secured in their correct position on the machined pattern-plate (Fig. 1 (*c*)). The print between each half of the pattern acted as a support between the two portions of the core which projected into the moulds on either side and the cores were thus balanced. Since it was necessary for the boss on the pattern to be in perfect alignment with the boss on the core, a means of accurately positioning the core had to be found. This was achieved by incorporating on the outer side of the balance-print a rectangular core-print, *A*, Fig 1 (*c*), and by cutting out such a rectangular impression in each half of the core-box to accommodate the print. This prevents the core from being misplaced or turning and therefore makes moulding fool-proof.

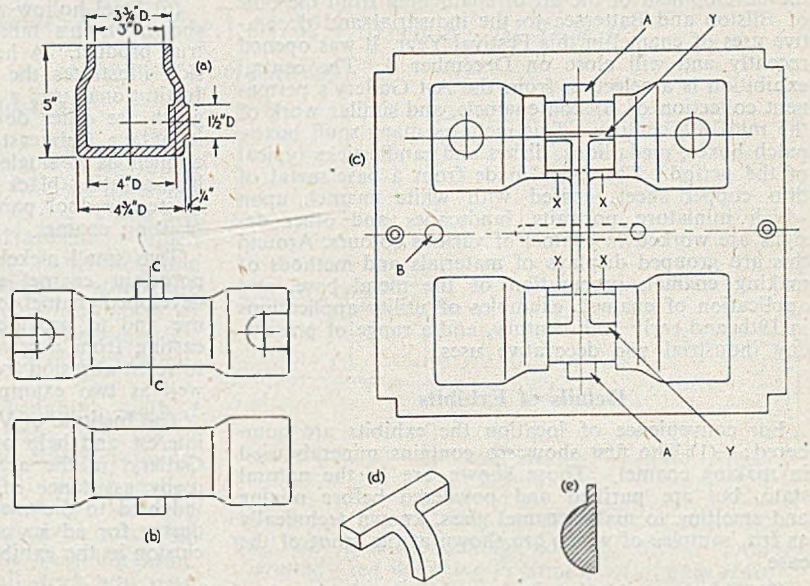

Fig. 1—*(a) Section through the Iron Casting Required; (b) Two Halves of the Core; (c) Layout of the Patterns mounted on a Machined Steel Pattern-plate; (d) Enlarged View of Ingate Y-Y and (e) Section through C-C.*

Shown at *B*, Fig. 1 (*c*), is a hemi-spherical knob turned in wood. This knob makes its impression in each mould produced, and is therefore a means of ensuring at a glance, as the moulds are being closed, that the castings turn out with only one boss on each casting. That is, it prevents two bosses being formed on two castings, and no bosses on the remaining two castings out of the same box as may arise if no method of correct matching is provided.

Two alternative suggestions are shown in Fig. 1 (*c*) for running the castings. In the first, *X—X* the ingate runs against the side of the core, and in the second at *Y—Y* the ingate runs over the core on the pattern, though when cast, this ingate is in the drag and is running underneath the core. The slag and dirt trap is shown by the broken lines, and, since the drag and cope are moulded from this single-side plate, the trap, runner-bar and ingates have to be dowelled to the pattern-plate. If the ingates which run over the core are considered too flimsy owing to short grain in the timber, then it would be advisable to cast two such ingates of aluminium.

New Laboratory Sand-mixer

Ridsdale & Company, Limited, of 234, Marton Road, Middlesbrough, have designed and placed on the market a quite small sand-mixer for laboratory use. It weighs only 100 lb., and measures 12 by 20 by 18 in., handling 2 to 5 lb. batches. It consists of an 8 in. dia. cylindrical pan carrying two shaped rotating blades at a speed of 35 r.p.m., driven by a ¼ h.p. geared motor. Bosses attached to the pan walls churn up the mix very satisfactorily. The motor is controlled by a time switch having a range up to an 8-min. maximum. The sand is discharged through a sliding door in the side of the pan down a chute. The blade assembly is detachable to facilitate cleaning.

The Council of Ironfoundry Associations is organising a conference on foundry recruitment, training and education to be held at Ashorne Hill, Nr. Leamington Spa, from March 12 to 14, 1952.

Tyne Craftsmen Return to Work

After a strike lasting 115 days about 200 craftsmen employed on maintenance work by the Tyne Improvement Commission have gone back to work following a wage award of 4d. an hour by the Industrial Disputes Tribunal. The increase is equal to 14s. 8d. a week. The men originally asked for 6d. an hour "port allowance." They claimed that they did not have the same opportunities for overtime and bonus rates as men in other shipbuilding and engineering works.

Negotiations were begun in September and proceeded for some weeks without any agreement being reached. The men decided to strike and although the matter was referred to arbitration the strikers decided to continue the stoppage until the result of the arbitration was known. At the outset some 240 men were involved but about 50 of these have obtained work elsewhere.

Festival Exhibition of Enamels

The exhibit arranged by the Midland Section of the Institute of Vitreous Enamellers in collaboration with the Art Gallery Committee, Wolverhampton, shows the development of the art of enamelling from the time of Bilston and Battersea to the industrial and decorative uses of enamel in this Festival Year. It was opened recently and will close on December 8. The central exhibition is a selection from the Art Gallery's permanent collection of Bilston enamels, and similar work of the mid-18th century. This includes many snuff boxes, patch boxes, medallions, dishes and candlesticks typical of the period. These are made from a base metal of thin copper sheet, coated with white enamel, upon which miniature portraits, landscapes and other designs are worked in enamel of various colours. Around this are grouped displays of materials and methods of making enamel; preparation of the metal base, and application of enamel; examples of utility applications in 19th and early 20th century, and a range of present-day industrial and decorative uses.

Details of Exhibits

For convenience of location the exhibits are numbered:—(1) The first showcase contains minerals used in making enamel. Those shown are in the natural state, but are purified and powdered before mixing and smelting to make enamel glass, known technically as frit, samples of which are shown at the front of the case.

(2) This is a table bearing sample enamel frits, clays and electrolytes, with a model-size grinding mill in which the enamel is ground with water to form a "slip." Typical small pieces of cast and sheet iron are shown in the raw state and at different stages in cleaning and enamelling.

(3) The third exhibit is of decorative cast-iron figures including "Dandy," in white ground-coat, with green, black, brown and flesh colour cover-coats, finished in gold, and burnished. Smaller figures are shown in colours, with a lustre finish. Examples of jewellery enamels include silver plaques, engine-turned, with transparent coloured enamels, and bronze pressings, with opaque enamel inlay work.

(4) Several signs from the end of the 19th century, some of which have been used in outdoor positions for over fifty years are on view, including work carried out in lithograph detail and with lettering and larger surfaces stencilled. A patented sign shows the use of metallic gold in combination with a rich purple enamel.

Cooker panels are typical of sponge mottle finish attained in three firings; this was a popular finish on cookers from about 1920 to 1930. Modern exhibits include a stove-door in majolica, applied by the wet process, using a lead-free enamel. This is comparable with lead-bearing enamels previously used by the dry dusting process. A roll of Mirawall enamelled sheet demonstrates the flexibility of enamel. The sheet is 0.0008 in. thick and is enamelled flat, with a coating of 0.006 in. each side. The sheet can be rolled on 6 in. radius, and when released will open out flat again. It may be used as a wall covering and can be cut with strong scissors. A gas-turbine flame-tube shows an industrial use of a special enamel to give protection from the intense heat of the burning fuel. Other similar uses are on aircraft exhaust-pipes and shrouds.

(5) This central group embraces a sulphonating pot, cover and mixer which are typical of cast-iron chemical-ware, made to meet many specifications, to withstand corrosive attack at high pressures and temperatures. Sizes are up to 1,000 gallons capacity and enamelling is by the dry dusting process. Wet-process enamels may be used for tank cars. Also included are fluorescent reflectors and a sheet-steel bath, fabricated from seven pressings by gas and electric welding.

(6) Steel hollow-ware, of which several examples are shown on this table, is a noted Black Country industrial product. A heavy oval pot with a pearl-grey inside illustrates the heavy-duty ware for canteen and Institutional use; a milk jug in blue, and wash-bowl in green are other domestic pieces. Cooker components include a hob casting in white acid-resisting enamel applied as a single coat, a burner top-bar casting in heat-resisting black (also one coat) and two pressings in steel, a door panel and a crown tray in cream acid-resisting enamel.

Two small nickel-chrome wire-resistances wound on porcelain enamel show an application of specially-developed enamel to secure the wires in position during use and to provide adequate insulation. A cylinder casting from a sewage pump, with hard-enamel lining to resist abrasion from mud and grit is also on view, as well as two examples of modern sign technique.

The Institute of Vitreous Enamellers acknowledge the interest and help of Mr. Roberts, Curator of the Art Gallery, in the arrangement of this exhibit, and the ready assistance of the staff in its installation. It is indebted to the many gentlemen and firms in the industry for advice and for the loan of articles for inclusion in the exhibit.

British and American Steel Prices

A recent feature of interest in the American steel industry has been the steady rise in prices, which have just about doubled since the end of the war. There is, moreover, states an article in the October "Statistical Bulletin" of the British Iron and Steel Federation, widespread expectation of a further advance before long, in view of the likely increase in steelworkers' wages towards the end of the year, when the current contract expires.

In the United Kingdom, steel prices showed only a very gradual upward trend until the increase of April, 1949, which was due in part to the transfer from the Exchequer of the losses on imported raw materials and semi-finished steel. Even after that advance, most steel products were still appreciably cheaper here than in the U.S.A.

Notwithstanding the 1951 increase which came into effect in mid-August, British steel prices still do not fully reflect the sharp rise in the cost of imported raw materials due to devaluation and other causes. It is hardly to be expected, states the "Bulletin," that so wide a margin between the prices at which steel products are supplied to the manufacturing industries in the two countries can be maintained indefinitely.

British and American Steel Prices. (Delivered per Long Ton.)

Product.	U.K. £ s. d.	U.S.A. £ s. d.	U.S. as percentage of U.K.
Wire rods	27 4 3	34 16 0	128
Angles	23 18 0	35 4 0	147
Joists	24 4 6	34 16 0	144
Plates	27 9 0	35 12 0	130
Bars	28 0 0	37 12 0	134
Strip	28 15 0	39 12 0	138
Rails	24 10 6	30 12 0	125
Sheets	35 5 6	40 16 0	116

Mechanical Charging of Cupolas*

Survey of Methods in Use and Principles Involved

By W. J. Driscoll, B.Sc.(Eng.), A.M.I.Mech.E., M.Inst.F.

(*Continued from page* 605.)

Arrangement of the Stockyard

The detailed arrangement of any stock yard for the storage of cupola raw materials will obviously depend on local site conditions, on whether materials arrive by rail, road, or canal, and so on. There are, however, certain aspects of the arrangement which can be considered in relation to the charge weighing method and the type of cupola chargers which are adopted, with a view to minimising the amount of manual labour involved in handling the materials between the incoming vehicles and the charge weighing point.

In all cases where the charge weighing method involves a fixed weighing point (*e.g.*, Figs. 23 to 33), where each component of the charge is to be weighed, and where the materials are to be loaded into the weighing container manually, working stocks of all charge materials should be available only a short distance away from the weighing point. Fig. 44 shows how a group of small stock bins may be arranged around a skip hoist with integral weighing machine as indicated in Fig 23. The same principle is applicable to other systems with fixed weighing points. The amount of each material which can be stored in the bins obviously depends on the number of materials concerned and the size of the area allotted, an increase in size meaning that the materials have to be carried further by hand. In most cases, permanent bins should be relatively small in size and replenished from time to time from the main stocks by means of overhead crane, where available, or some form of ground-level wheeled transport.

A system installed in at least one foundry in the U.S.A. is worthy of mention. The charging bucket stands, for loading, on a scale platform in a small pit (similar to Fig. 24). Stock bins are arranged radially around the pit and in the floor of some of these bins are apron plate conveyors terminating at the edge of the pit. Operation of each conveyor carries material from the bin into the bucket until the correct weight, as indicated on the scales, is loaded, the conveyor then being stopped.

A desirable alternative, under some circumstances, to the permanent bin arrangement indicated in Fig. 44 is for the bins to be in the form of stillages which are loaded at the main stock piles and then brought by power truck to be grouped around the weighing point.

Where the weight to be handled and the size of the charges are sufficient to warrant it, an overhead crane and magnet can be used to bring ferrous materials direct from the main stock piles and to

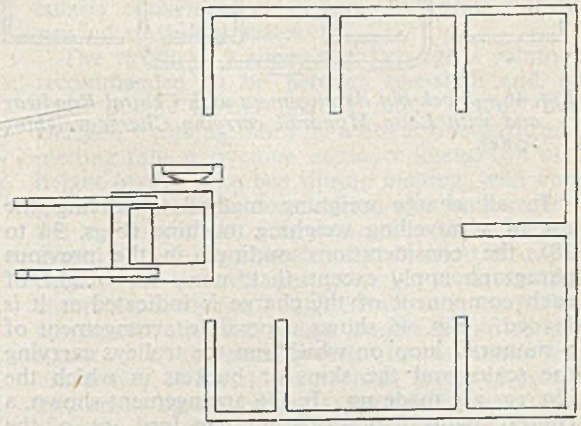

FIG. 44.—*Bins containing Working Stocks grouped around fixed Weighing Point at Foot of Skip Hoist.*

deposit them straight into the weighing container, this arrangement requiring only very small stocks at the weighing point for the final trimming of the charge weight.

In cases where the metal charge is made up in a travelling skip or container (as in Figs. 27, 28, 30, 31) and the weighing machine is used only to check the total weight of the metal charge, and not to weigh the individual components, then the charge container can be moved to each of the stock bins in turn for the particular component to be loaded, then passing over the weighing point on the way to the pick-up point. Fig. 45 shows an arrangement of this type as it may be applied to the charge weighing methods shown in Figs. 27, 28, 30, or similarly, Fig. 31. As there is not the same need as in the Fig. 44 arrangement to keep the total area of the bins small, each bin may have a larger capacity and may, in fact, sometimes be used for main storage. While Fig. 45 shows a single straight track for the charge container, the track may be arranged as a loop, particularly if of the monorail type, and the bins grouped accordingly.

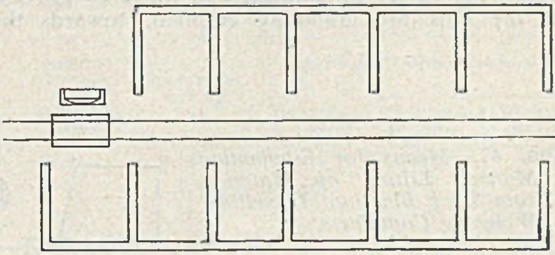

FIG. 45.—*Stock-bin Arrangement where Charge is Made-up in Travelling Skip or Container and Weighed on the way to the Pick-up Point.*

* Paper presented at the annual conference of the Institute of British Foundrymen, Mr. Colin Gresty in the chair. The Author is attached to the British Cast Iron Research Association.

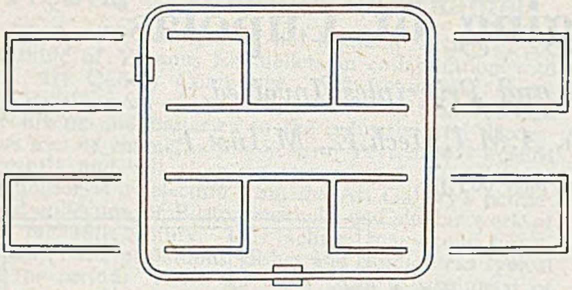

FIG. 46.—*Stock-bin Arrangement with Central Roadway and with Loop Monorail carrying Charge-weighing Scales.*

In all charge weighing methods involving the use of a travelling weighing machine (Figs. 34 to 38), the considerations outlined in the previous paragraph apply except that, now, the weight of each component of the charge is indicated as it is loaded. Fig. 46 shows a possible arrangement of a monorail loop on which run the trolleys carrying the scales and the skips or buckets in which the charges are made up. In the arrangement shown, a central roadway or rail track can feed any of the bins, provided that the adjacent bin walls are of a suitable height. The pick-up point can be at any convenient location along the track of the monorail. There are, of course, an infinite number of arrangements of the weighing track and of the stock bins including types similar to that shown in Fig. 45.

The physical effort involved in loading materials from a stock bin into an adjacent skip is considerably reduced by arranging that the level of the bottom of the bin is just above the top of the skip so that the materials may be more or less raked off the floor of the bin into the skip without any lifting being necessary. In practice, this means (*a*) that the bins are at ground level while the skips travel along a sunken channel, or (*b*) that the skips travel at ground level and the stock bins are elevated. Indications of how these methods have been applied are shown in Fig 47. The left-hand illustration shows a charge weighing container, suspended from a dial scale and monorail, running in a channel between two lines of stock bins. The right-hand diagram indicates a scale car, carrying a charging bucket, running at ground level between lines of elevated bins. These bins may have part of their floor inclined, as shown, so that there is a natural tendency for materials to move by gravity, as the bins are gradually emptied, towards the working edge where they are required. Elevated bins must generally, of course, be stocked by means of an overhead crane. In some smaller installations it is conceivable that a system intermediate between the two described—involving high stillages and a shallower channel—might be practicable.

The value of some form of overhead crane in the cupola stock yard is readily apparent. Factors such as the site conditions and the tonnage of materials to be handled govern the degree to which expenditure can be justified on such cranes.

The duties which may normally be performed by cranes include (*a*) cupola charging, (*b*) movement, with magnet attachment, of pig-iron and scrap from the stock bins direct into the charge weighing container, and (*c*) the unloading of incoming vehicles and the general handling of material into and out of stock bins and hoppers.

In some cases it is possible for a travelling crane, of one of the types shown in Figs. 19 to 21, to serve both for cupola charging and for general handling during the periods when it is not required for charging. Monorail or similar types of charging crane, as illustrated in Figs. 12, 13, 17, 18, are not so suitable for yard use as the area covered is limited to a very short distance on either side of the line of travel. In other cases, where one travelling crane is used for charging, it may be necessary to have one, or even two, more cranes to fulfil the additional duties, dependent on the anticipated time for which each will be in use. The additional cranes may be on the same track as the charging crane, on an adjacent parallel track, or may be arranged at different levels to suit the particular circumstances.

Bulk Density of Cupola Raw Materials

A knowledge of the bulk density of pig-iron, scrap, coke, etc., is valuable in assessing the capacity of storage bins, in designing skips and buckets for charging, etc. Values are therefore given in Table V. It must be emphasised that the figures in the Table are essentially approximate as other factors such as the size and shape of the container have an influence on the density. For instance, the bulk density is reduced as the size of the container, relative to the lump size of the material being loaded, is reduced. Thus, when designing a charging skip or bucket to accommodate a given weight of material, it is preferable for a typical charge to be loaded into a container of similar size and shape to that of the proposed skip before the design is finalised.

FIG. 47.—*Means for Eliminating Manual Lifting of Materials from Stock Bins into Travelling Weighing Containers.*

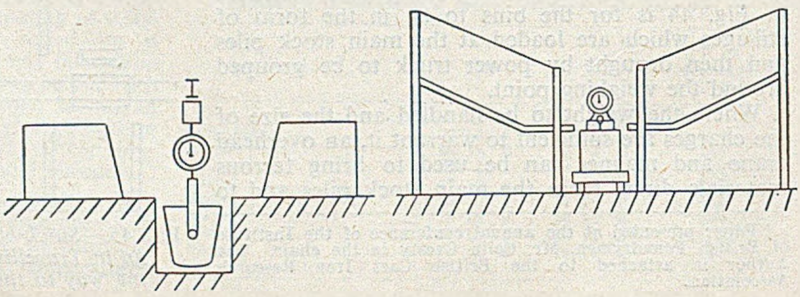

TABLE V.—*The Approximate Bulk Density of Cupola Raw Materials*

Material.	Bulk density, cwt./cub. ft.
Coke	¼
Limestone (see Note below)	¾
Pig-iron (sand- and machine-cast)	1¾ to 2
Cast-iron scrap :	
Light hollow-ware, radiators, boilers, rainwater pipes, etc.	½ to ¾
Other light castings scrap	¾ to 1¼
Cylinders, cylinder blocks and heads, etc.	¾ to 1
Heavy engineering and machinery scrap	1¼ to 1¾
Steel scrap :	
Constructional steel, rails, fish-plates, etc.	1½ to 2
Tubes, bolts, stamping scrap, etc.	¾ to 1½

Note.—A mixture of large and small pieces of scrap may result in a bulk density higher than that of either the large pieces or the small pieces alone. Similarly, in a charging skip or bucket, the limestone lumps normally occupy the voids in the coke or metal charge and no extra allowance need be made for the space taken up by the limestone charge.

Metal Charge Weight and Frequency of Charging

It is fairly common practice for the recommended weight of a single metal charge for a cupola of a given size to be expressed as a fraction of the hourly melting rate. This automatically decides the average speed at which the charges are loaded into the cupola. Thus, if the weight of the metal charge is to be, say, one-tenth of the hourly melting rate, then the average speed of loading will be ten per hour, or one every six minutes. The whole of the charging, charge weighing and materials handling equipment then needs to be designed with this factor in mind. For instance, in the case quoted, the speed of the hoist or crane used for charging must be such that one complete charging cycle can be completed in six minutes if the bucket or skip contains both the metal and the coke (or if the coke is charged from the platform) or in three minutes if the coke is charged separately from the metal, allowance being made in either case for any time necessary for loading the materials into the charger, the hooking-on and disengaging of skips or buckets, etc.

Whether or not the weighing of the charges needs to keep to the same duration of charging cycle depends on whether it is practicable and possible for some weighed charges to be stored in reserve. For instance, in a case where a cupola melts only during the afternoons it may be considered preferable for making-up and weighing of the charges to be going on during the mornings, these completed charges being set aside in readiness for the afternoon. In such a case the time cycle for weighing may be, say, twice as long as the charging cycle. The weighing method or type of charger must, however, be of a type which permits the completed charge in its container to be removed from the weighing point and stored at a convenient location.

Alternatively, in the case just mentioned, the making-up and weighing arrangements may be such that the time cycle corresponds with the charging cycle so that no charges need to be stored. This method is probably almost essential where melts are of a full shift's duration or longer. Arrangements which permit a small reserve of two or three completed charges are of advantage in smoothing-out slight temporary differences between speeds of weighing and of charging.

Where the frequency of charging is high due to the use of small charges, or where the speed of making-up and weighing tends to be low due, possibly, to the use of a large number of different charge components, then it may be necessary to use two, or even more, weighing stations. This is particularly convenient on a loop monorail with suspended travelling scales.

The weight of a single metal charge is commonly recommended to be between one-sixth and one-tenth of the hourly melting rate. Unduly heavy charges, weighing more than about one-sixth of the melting rate, may cause excessive fluctuation of the height of the coke bed during melting, with consequent variations in composition and temperature of the molten metal. Where metal needs to be maintained at a fairly constant composition, and particularly if the charges contain very dissimilar components such as bought scrap, steel scrap, ferro-alloys, etc., then the charge weight should be about one-tenth of the melting rate. In conditions where uniformity of metal quality is of prime importance and small quantities are tapped at a time without the use of a receiver, then it may be necessary for the charges to be as small as one-sixteenth of the melting rate. Table VI lists, for reference, the metal charge weights for various sizes of cupolas under the three headings of six, ten and sixteen charges per hour just mentioned.

The amount of coke in each charge will be so proportioned to the metal charge weight as to give metal of the required temperature under the particular conditions of operation. The weight of limestone per charge, in turn, will be proportioned to the coke weight in order to obtain a slag of suitable composition and fluidity in accordance with established practice.

Labour Requirements

Some indication of the amount of labour which it is expected will be required in any particular proposed installation is obviously desirable in deciding the extent to which mechanical handling methods can economically be introduced. In cases where virtually all movement of materials is effected mechanically, the labour requirements tend to depend more on the number of mechanical operations to be controlled than on the

TABLE VI.—*Schedule of Metal Charge Weights in Accordance with Various Frequencies of Charging.*

Internal diameter of lining at melting zone.	Approximate melting rate.	Approximate metal charge weight.		
		6 charges per hour.	10 charges per hour.	16 charges per hour.
In.	Tons/hr.	Cwt.	Cwt.	Cwt.
24	2.4	8	5	3
27	3.0	10	6	4
30	3.7	12	7½	5
33	4.5	15	9	6
36	5·3	18	11	7
39	6.2	20	12½	8
42	7.2	25	15	9
48	9.4	30	20	12
54	11.9	40	25	15
60	14.7	50	30	18

Mechanical Charging of Cupolas

weight of material to be handled. Thus in a fully-mechanised system not more than about three men may be required for making-up and charging for one or two cupolas, even if of very large size. Therefore, in a foundry handling large tonnages, appreciable capital expenditure on handling equipment can be incurred in view of the saving in labour compared with normal hand charging.

With small installations the difference in labour requirements between hand charging and a fully-mechanised system may be small or even non-existent so that full mechanisation is seldom justified and capital expenditure may be limited to a simple form of skip hoist or charger alone, making-up, weighing and horizontal movement of materials being performed manually.

In most cases of intermediate size, a compromise needs to be reached whereby the expenditure incurred on mechanical equipment for materials handling and charging is adequately offset by the resultant saving in labour, this compromise often falling short of a completely mechanised system requiring only, say, three men.

Little information has been collected and published in this country on the labour involved in the charging of various sizes of cupolas with various methods of charge weighing and charging. Data relating to certain installations in the U.S.A. are, however, of interest. It will be noted that most of the installations are large and all may be described as being fully mechanised in that little or no manual handling of charge materials is involved.

Case 1.—Four cupolas in all. Each 48-in. internal diameter, melting at 7½ tons per hr. Two cupolas used together each day, *i.e.*, total melting rate, 15 tons per hr. Cupolas charged by means of cone-bottom buckets (see Fig. 7) carried on an underslung travelling crane charger (see Fig. 20). Metal brought direct from main stocks by means of magnet on overhead travelling yard crane (parallel and adjacent to charging crane) and dropped into batch weigh hopper incorporated in elevated make-up platform (see Fig. 32). Completed metal charge dropped into bucket standing on powered transfer car (Fig. 32). Car and bucket then move to coke and limestone hoppers and receive these materials from separate batch weigh hopper (see Fig. 41). Car then moves to pick-up point. Total labour requirements: Three men—one on yard crane, one operating transfer car and coke and limestone hoppers, one on charging crane.

Case 2.—One 72-in. dia. cupola only, melting up to 16 tons per hr. Metal charge weight, 4,000 lb. Maximum charging rate, nine charges per hr. Cupola charged with cone-bottom bucket and inclined bucket hoist (see Fig. 14). Metal brought direct from main stocks by means of magnet on overhead travelling yard crane and dropped into ground-level batch weigh hopper (see Fig. 26). Completed metal charge dropped into bucket which is in position on the hoist. After the bucket has charged the metal into the cupola, it is run back to a position just below the charging platform. Coke and limestone, previously weighed and stored on the platform in skips, are then tipped into the bucket. After these materials are charged, the bucket returns to ground level for a further metal charge. The hoist is controlled from the charging platform. Total labour requirements: three men—one on yard crane, one helper at ground level adjusting the metal charges, one on the charging platform for coke and limestone.

Case 3.—Two 72-in. dia. cupolas (up to 18 tons per hr. each) and one 66-in. cupola (up to 12 tons per hr.). One, two, or three cupolas used together according to foundry requirements (*i.e.*, gross melting rate up to 48 tons per hr.). Metal charge weight, 3,000 lb. Gross charging rate up to 36 charges per hr.

Cupolas charged with cone-bottom buckets carried on travelling gantry crane charger (see Fig. 22). Metal brought from main stock bins on magnet on yard crane and dropped into charging bucket standing on short length of powered roller track on platform of sunken weighing machine. Charged bucket rolled off scales on to powered scale car running in underground tunnel. Coke and limestone received from hoppers discharging through tunnel roof. Car then runs to pick-up point, where bucket raised through aperture in tunnel roof by charging crane. Total labour requirements: four men—one on yard crane, one helper at metal charge weighing point, one man on powered scale car and one on charging crane. Labour requirements when hand-charging, up to 19 men.

Case 4.—Four 48-in. dia. cupolas, each melting at 7 tons per hr. Two cupolas used together each day. Metal charge weight, 1,500 lb. Gross charging rate, 20 charges per hr.

Cupolas charged with cone-bottom buckets on telpher-type radial monorail charger (see Fig. 18). Materials stored in two lines of elevated bins and hoppers (see Figs. 42 and 47), each line serving a powered scale car, the two cars running on separate, adjacent, parallel tracks. Buckets moved between the scale cars and the pick-up point by gravity roller track (see Fig. 38). Total labour requirements: four men—one on each scale car, one helper for making-up, one on the telpher charging crane.

Mechanical Aids on Conventional Charging Platforms

It has been mentioned previously that, with mechanical charging systems as so far described, a large substantial charging platform of the conventional type may not be required. In existing installations where a platform is available, however, use can sometimes be made of mechanical equipment on the platform in order to reduce the labour requirements for making-up and charging. This may be particularly valuable where a foundry is short of ground-level storage space.

A platform will, of course, normally be provided with mechanical means for raising the materials from ground level, generally in the form of a goods lift. Thus the charges may be made-up and weighed at ground level and brought up in the lift in individual skips or barrows to be tipped from the platform into the cupola, or the materials may be

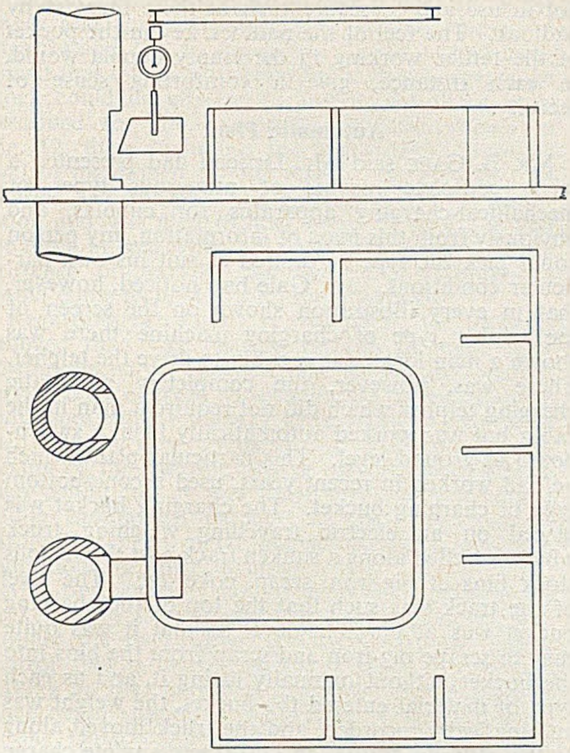

FIG. 48.—*Stock Bins and Loop Monorail carrying Charge-weighing Scales, all being arranged on the Charging Platform.*

brought up in bulk in wheeled skips which are then grouped around the weighing point. Where conditions are suitable, power trucks may be used at ground level or on the platform for handling skips or stillages, while, if the lift is large enough, the power truck may travel with its load from ground level to the platform. The power truck can be so fitted that it can be used for the tilting of charged skips into the cupola.

One type of installation which can often be applied usefully on existing charging platforms is shown in Fig. 48. The method of operation is similar to that previously described for ground-level making-up in which a weighing skip, with integral scales, is carried on a monorail. The trolley supporting the scales and skip is pushed along, generally by hand, to each of the bins in turn and the completed charge is then tipped direct into the cupola in use. If the manual effort required to tilt the skip is too great, then a small pneumatic or electric hoist may be attached to the back end of the skip for tilting. As in previous cases, the stock bins need not be of the permanent construction indicated in Fig. 48, but may be the stillages or wheeled skips in which the materials are brought up on to the platform.

Conclusion

An attempt has been made to summarise the various methods which are in use for reducing the manual effort associated with the charging of cupolas and with the handling and weighing of the charge materials. More stress may have been laid on certain types of equipment in use in the U.S.A., possibly with less than full justice to certain British installations. It is hoped, however, that this Paper will be of some interest and assistance to foundries and to foundry equipment manufacturers, to the benefit of the efficiency and productivity of the industry.

Acknowledgments

The Author's thanks are due to the Director and Council of the British Cast Iron Research Association for permission to present this Paper, and also to the managements of numerous firms in which installations of the types of equipment mentioned in the Paper are in use. In addition, he has drawn freely from trade publications of various equipment manufacturers, particularly the Whiting Corporation of Harvey, Illinois.

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DISCUSSION

MR. GREAVES asked what was the smallest size of cupola which could be serviced by an electro-magnet. There seemed no advantage with small-size cupolas, where a man might have to pick big pieces out of the charging skips and substitute smaller ones in order to get the correct weight. Was there an optimum size of charge which would allow for the variation of a magnet load and with the metal cast still within the composition range?

MR. DRISCOLL said it depended more on the size of the bucket than on the size of the cupola. In turn, the size of the bucket depended on its type. For instance, the controlled-discharge type of bucket had to be smaller for a given size of cupola than some of the trip-discharge types. Very generally, it was doubtful whether it would be practicable to load buckets smaller than 30- or 36-in. dia. with a magnet, which meant, depending on the type of bucket, that it would not be practicable to make up charges for a cupola with a magnet unless the cupola was at least about 48-in. internal dia. at the charging door. The diameter of the cupola shaft could, of course, be less than this, but it was doubtful, with normal

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mixtures, whether the control over the magnet discharge would be sufficiently fine for a cupola melting less than 5 tons per hr., say 36-in. dia.

Bottom-discharge Buckets

MR. W. W. BRAIDWOOD, congratulating the Author on his Paper, praised particularly the use of the simple line drawings. He said he was sure that this Paper would be a work of reference for years to come, and he could well imagine many foundry managers quoting it in their discussions with their directors on the question of new installations of equipment for cupola-charge preparation, *etc.*

The basis of good cupola practice was to weigh, with reasonable accuracy, each constituent of every charge, and he stressed the point made by Mr. Driscoll that weighing should be made as simple as possible. If the operator was asked to move weights on a steel-yard, he would probably do so only while the foreman was near. That was one great advantage of the dial-registering scale which had come into greater use over the past several years.

Mr. Braidwood regarded tilt-charging of cupolas as a bad method, and it was his contention that, wherever it was found necessary to face a cupola back wall with cast-iron blocks, the charging method was thereby shown to be unsatisfactory. Tilt-charging had the advantage of relatively low initial cost, but he would recommend anyone about to consider adoption of this method to ask himself if he could not do better. The bottom-opening bucket was far more satisfactory and he thought that in the United States, manufacturers of cupola-charging equipment had done much more than their British counterparts to facilitate the use of bucket charging, especially as applied to fairly small cupolas. In many cases, they eliminated the need for a charging platform or separate charging crane, and the buckets, filled at ground level, were lifted and discharged in a single operation. He felt that it was along this line that something much more suitable for the small cupola than the tilting skip could be applied.

Limitations and Precautions

The trip-discharge bucket, however, was functionally rather less satisfactory equipment, because, even when it did discharge its load in the proper place, it allowed its contents to fall bodily into the furnace. With the controlled-discharge bucket, however, sudden "dumping" of the contents was avoided and delivery could be arranged at a fairly steady rate. This was a matter of particular importance at the commencement of charging, when the first charges had to fall from sill level to the top of the coke bed.

Mr. Braidwood advised the many operators of mechanical-charging equipment to invest in a simple safety item, namely, a padlock. This could be used in the case of plants employing two-way chutes for ensuring that the lever controlling the direction of the falling materials could not possibly be moved, except when authorised. In the case of plants using the bottom-discharge bucket, the best safeguard was to fit a steel bar across the door of cupola or cupolas not in use and to secure each of these likewise by padlock. The feel of the padlock key in the pocket of the fettler working in the empty cupola would, in each instance, give a comforting sense of security.

Automatic Plant

MR. B. GALE said Mr. Driscoll had presented a fairly complete *résumé* of numerous types of mechanical-charging apparatus for cupolas, and obviously from this mass of information, any person could pick the type he desired to suit his own particular conditions. Mr. Gale had noticed, however, that in every illustration shown on the screen of the telpher type of charging machine there was shown a man located in a cabin to drive the telpher. There was, however, the completely automatic charging telpher which did not require a man in the cabin but was worked automatically from a switchboard at ground level. This particular plant, which he had worked in recent years, used a cone-bottom type of charging bucket. The charging bucket was placed on an electric travelling weighing truck which travelled along a sunken track past the various stock bins of pig-iron, scrap, coke, *etc.* The level of the track was such that the top of the charging bucket was at bin-floor level so that it was quite easy to scrape pig-iron and scrap from the bins into the bucket without manually lifting it, and as each type of material entered the bucket, the weight was automatically recorded, and the truck moved along to the next bin and so on until the complete charge was in the bin. When the complete charge was loaded, the truck was driven underneath the hoist rope of the telpher and connected. Then by one press of a button, the telpher automatically hoisted the bucket to the charging-hole level, traversed forward into the cupola, lowered the bucket until it rested on the "wishbone," discharged the metal into the cupola, hoisted, withdraw from the cupola on traverse, and lowered the bucket back to floor level on to the travelling electric truck. This entire arrangement worked with an automatic time-control switch arrangement on the telpher block, and Mr. Gale said he had never known any serious trouble with the electrical equipment. He had had an occasional electrical breakdown of small duration which necessitated an electrician going on to the telpher platform to work the switches by hand for such short time as was necessary to replace a blown fuse or any similar occurrence, but never had he known a breakdown which had stopped the charging of the cupola.

Iron and Coke Together

There was one other question he would like to ask Mr. Driscoll, and that was whether he believed in charging coke and iron in the same bucket. Mr. Gale preferred to send coke and limestone into the cupola in one bucket and then follow with the metal charge in another bucket, because he thought that with mixed charges of coke and metal, certain of the materials would be sure to ricochet from the furnace walls and consequently one would not get a complete coke split in between the metal charges.

MR. DRISCOLL said that the installation described by Mr. Gale appeared to be a combination of the monorail crane-charger illustrated in Fig. 18 of the Paper and the charge-weighing method shown in Figs. 34 and 47. In describing Fig. 18 he had mentioned that the electrical control of the charger-hoist block could be effected in any of the three ways described for the monorail skip-hoist shown in Fig. 12, these including the completely automatic control mentioned by Mr. Gale. Nevertheless, he himself had not seen this particular type of installation and was glad to hear about it, as it justified the hope he had when preparing the Paper that the existence of unusual but successful installations would come to light during the discussions.

Regarding Mr. Gale's second point, Mr. Driscoll believed that coke charged on top of metal in a bottom-discharge bucket could be just as satisfactory as coke charged separately, the former method sometimes being necessary when small charges were used with a view to increasing the efficiency of mixing of the metallic charge constituents. Under such conditions, it was more important to avoid undue mechanical damage to the coke than to ensure that each metal charge was covered by a continuous, uniform layer of coke.

Mr. Spriggs on the question of charging by bucket or by skip agreed that it saved labour, but thought the over-riding advantage was the better control that it made possible. When a man was making up his charges at ground level there was a much better chance of seeing what was being done.

Mr. Driscoll agreed that the making up of charges at ground level was an important item in the list of advantages of mechanical charging. It might be that the reduction in labour was the best argument to use with the board of directors when trying to install equipment, but he thought the technical staff would undoubtedly place the second factor first in importance.

Height of Charge

Mr. H. P. Hughes agreed in the main with what had been said as to possible economies with mechanical chargers, but there were occasions when it was desirable and necessary to hand-charge a cupola when skip hoists were used. It was his experience that if uniform distribution of the charge had to obtain, the early charges in the cupola required to be hand-charged. Immediately the cupola was filled, it was then satisfactory to operate with the skip-hoist.

Mr. Driscoll would appear to indicate that such a procedure was desirable when he said it was desirable to maintain uniform working height when the cupola was running, and the uniform height was fairly critical. That in certain cases necessitated a man on the cupola stage, where the skip-hoist was working from the ground level, so as to maintain the level at the required height. If it became too high there was a build-up at the back of the cupola and if it got too low there was a tendency to get a build-up in the front of the cupola. The position was critical and required attention. Another point which had been stressed and with which he agreed, was the method of ensuring that the necessary precautions were taken in guarding against accidents when a common hoist of the fixed type was used to charge two cupolas working on alternative days.

Mr. Driscoll thought Mr. Hughes had touched on a real problem when he referred to the difficulty of indicating the height of the charges to anyone on ground level, with a view to eliminating the need for anyone to be standing on the charging platform. There was scope for some simple reliable device to be provided which would indicate the top level of the charges in the cupola to anyone at ground level.

Stock Height Indicator

Mr. B. Gale said that he could probably help to answer the question by enlarging upon his previous remarks on the automatic cupola charger. This particular installation was so arranged that the charging platform was on one level, the cupola on a second level and the stock bins on a third level, so that the total distance from the men weighing the charges to the charging hole in the cupola, was approximately 50 ft. He had installed on to the cupola shell an ordinary electric "eye," which, according to the height of metal in the stack, would alternately light a red or white electric lamp at the stockyard level. When the red light was burning, it indicated that the cupola was full, and when the white light was burning, the intimation was that the burden had sunk below a certain level and there was space to send a further charge up to the cupola, and so by this simple method, the men working 50 ft. below the cupola charging-hole could easily tell whether the furnace needed charging or not, and this gave no difficulty whatever.

Breakdowns

Mr. J. E. O. Little said with all the mechanical charging systems which they had been shown there was no diagram of a stand-by plant. In view of possible breakdowns what simple equipment could be used when the main system would not work?

Mr. Driscoll said that the matter could be considered only on the basis used when considering possible breakdowns in other types of machinery. Taking into account the reliability history of the type of equipment envisaged and the consequences of a breakdown, the foundry would need to consider, before proceeding with the installation, the degree to which it would be economically justified in putting in platforms, lifting gear, *etc.*, which would be redundant in normal working. Some types of chargers, for instance the monorail type, lent themselves more readily than others to the installation of stand-by hoists.

Eliminating a Risk

Mr. A. E. McRae Smith, m.a., raised a point which he thought Mr. Driscoll had not touched on. When there were two cupolas charged by an inclined plane charger there were two chutes and it had been stated in the discussion the charges might be sent down the wrong one. One of the most modern methods used in this country was to have the inclined-plane charger mounted on a swivel serving both cupolas and that made it impossible to deliver the charge to the wrong cupola. He believed there were four or five installations in this country working on those lines. It was, he

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thought, a great improvement on the ordinary-type inclined-plane charger. Had Mr. Driscoll any experience of that model.

Mr. Driscoll said he could not recall having seen a skip-hoist which pivoted in the same way as the bucket-hoist shown in Fig. 15 of the Paper, but he had no doubt that such a charger could very easily be designed and would overcome that particular danger. As an alternative, of course, there was the travelling type of skip-hoist shown in Fig. 11 of the Paper.

Bucket Charging of Small Cupolas

Mr. D. Fleming thought the Paper would save a large number of people much time and energy in the future when they had to prepare cupola-charging schemes. He had no criticisms to offer on the Paper but with the chairman's permission, would like to cross-question Mr. Braidwood on the small-diameter cupola and the various methods of charging it. He had just spent a considerable time on the development of a cupola-charging scheme, and if Mr. Braidwood could tell him how one could effectively charge an existing cupola of 33 to 36 in. dia. with a drop-bottom bucket which did not harm the sides of the cupola and did all the things Mr. Braidwood would like it to do in the manner of a cone-bottom charger he would be very interested to learn the solution. He appreciated the criticisms but would like to know if Mr. Braidwood could give an instructive illustration.

He would also support Mr. Gale in the point he made about charger operation entirely from the ground. In addition to the plant mentioned by Mr. Gale, there was also a recent plant in Lancashire and he thought the plant referred to was developed after the publication of a Paper by Mr. Braidwood in which a drawing of the layout was given with the monorail running through the stock pens. In the case quoted, he believed the charges were transferred to a second monorail which was in the roof of the hoist. The vertical hoist raised the drop-bottom bucket on to the controlled system which moved forward and in doing so removed a complete section of the cupola. There was no charging door, but a section of the cupola was bodily pushed out of the way by the charger. The bucket was dropped and as it was removed the portion of cupola came back into position by means of weights. There was no one on the platform and the whole thing was worked by remote control.

In reply to Mr. Fleming, Mr. Braidwood said that, in his opinion, improvement in mechanical charging as applied to cupolas of small diameter, lay in the use of controlled-discharge buckets which could be charged at ground level, then raised and discharged in one operation without the use of a crane.

Mr. Fleming thought that as the charging-bucket diameter was diminished, it limited the size of material which could be charged almost to a ridiculous limit. There must be a clearance in the cupola between the bucket and the bucket entry.

Mr. Braidwood replied that there was no difficulty of the type mentioned by Mr. Fleming. As Mr. Driscoll had made clear in his Paper, the diameter of the cupola above sill level could be increased as required to give ample clearance for the bucket, which could therefore be of diameter approximately the same as that of the lined cupola at the melting zone.

Mr. Driscoll added, in confirmation, that he believed there might well be great possibilities in the development of bucket-charging systems for relatively small cupolas by providing a chamber of generous dimensions at charging level above the cupola-shaft proper.

WRITTEN COMMENT

Limestone Distribution

Mr. W. R. Jaeschke and Mr. C. McGlone (Whiting Corporation) wrote that the Paper was a very complete and thorough discourse on mechanical charging. In discussing the relative merits of different types of skips and buckets, the Author pointed out that "due to the inclined discharge from the skip, there is a tendency for non-uniform distribution of the charges across the cupola. For instance, the metal charge may be thrown to the far side of the furnace while the coke tended to fall on the near side." This was true of practically every "chute-loading" system, whether it be skips, wheelbarrow or bogies. However, another serious form of segregation existed that was not mentioned in the Paper and was overlooked by most operators, this being the lack of good distribution of the limestone. It generally also fell on the near side. This condition caused excessive fluxing of the lining on that side and excessive bridging of the tuyeres on the other side, so that the blast velocity and intensity of melting were higher on the near side.

Similar non-uniform distribution could result from the best drop-bottom type buckets if the buckets themselves were loaded non-symmetrically by means of chutes, or raking material in from bins. The best loading, best distribution, and most efficient cupola operation resulted when the cone-bottom bucket was used and loaded from overhead, with the bucket centrally located under loading device, with material dropped vertically into the bucket. Vertical loading afforded the best opportunity of filling the buckets symmetrically and this feature could be emphasised more.

Coke Unloading

The Author stated that "the unloading of coke from wagons by means of a grab on an overhead crane, while practised in some installations in the U.S.A. would not appear to be desirable because of consequent coke breakage." The writers agreed that the use of clamshell buckets for handling coke did damage the coke, but pointed out that this practice was fairly general in the States and that practically all the large mechanised foundries unloaded their coke by grab bucket. Regardless of how coke was handled, there was a certain amount of breakage and the policy was to attempt to provide enough storage space so that the coke was handled only once. They believed that this method was the most practical way to unload coke.

In reply, MR. DRISCOLL wrote that Mr. Jaeschke and Mr. McGlone had, in referring to possible poor distribution of limestone when skip charging, drawn attention to an important point. He could confirm that the effects of uneven distribution were as had been stated and could be serious. Where the limestone was scattered on top of the coke in the skip, as was normally the case, and steps were taken to see that the coke was well distributed, then the limestone was normally spread fairly evenly also, but not necessarily so, and the point needed to be watched.

The present contributors had also mentioned another point not included in the Paper, namely, possible unsymmetrical filling of charging buckets when loaded from the side and not from directly overhead, as from a make-up platform or overhead hopper. The Author felt that while this trouble was likely to be more serious with, say, cone-bottom buckets than with the centre-opening type, he would not expect it to be a very important factor in most British installations where the average bucket size was likely to be smaller than in many plants in the U.S.A.

THE AUTHOR noted with interest the comments relating to the handling of coke by means of a grab. While this method appears justifiable in many cases in the U.S.A., and while the policy of keeping to a minimum the number of times the coke is handled is certainly a good one, it seemed doubtful whether the use of grabs would become widespread in Great Britain for the time being, mainly because of the much smaller rail wagons used here, which increased the amount of labour required for trimming after the grab had been used.

The chairman closed the session with a vote of thanks to Mr. Driscoll for a most informative Paper.

Seven-day Week Foundry

A Larbert (Stirlingshire) foundry have found a way of working which boosts their weekly production by ten per cent. This foundry makes water-heaters for new houses, cash register and typewriter parts for export, castings for rearmament. Any iron casting, in fact, from 6 ozs. to 6 tons. The firm have obtained this increase by going on a 7-day week. Roughly half the firm's 300 employees now work on Saturday, and the rest come in on Sunday; workers do a full nine-hour shift and directors turn out, too. The firm first tried out the idea some years ago to catch up with a flood of orders and at spasmodic intervals since, but now it has been established as a regular practice.

Recently the firm took over a foundry in Dunfermline to produce heavier castings. They brought in new methods and a longer week. Now the foundry will soon be on a full 7-day week. Last week another Larbert firm invited its employees to come in and work on Sunday. The experiment was a success and is likely to be repeated.

Student's Grant. On the recommendation of the assessors, the student's grant for 1951 of the Institute of British Foundrymen has been awarded to Mr. Gordon Foster, who has elected to take a course at the National Foundry College. Mr. Foster, who is an associate member of the Institute, is in the employ of J. Blakeborough & Sons, Limited, Brighouse.

Personal

The Minister of Supply, Mr. Duncan Sandys, has appointed MR. HENDRIE OAKSHOTT as his Parliamentary Private Secretary. Aged 47, Mr. Oakshott has represented the Bebington Division since February, 1950.

MR. GORDON MOSELEY has been appointed to represent Greenham Equipments, Limited, contractors plant and machinery merchants, of Greenford (Middx), in Middlesex, Oxfordshire, Bedfordshire, Hertfordshire, and Buckinghamshire.

A PRESENTATION is to be made in the Town Hall, Wednesbury (Staffs), on December 11, 1951, to MR. T. G. BAMFORD, who is retiring from his post as Principal of the County Technical College, Wednesbury. During the 23 years he has held the headship of the College, Mr. Bamford has greatly developed the work of the College, particularly in its service to the metallurgical trades. He has made a notable contribution to the technical training as it has evolved in the apprenticeship schemes of several well-known foundry firms in the area. During his term of office at the College the number of students has increased six-fold.

MR. D. SHARPE, past-president of the Institute of British Foundrymen, and MR. J. J. MARAIS, the president of its South African Branch, were amongst the honoured guests at the annual banquet of the Steel and Engineering Industries Federation of South Africa which recently took place in Johannesburg. An outstanding witticism was made during a speech by Mr. Leon Cachet: "There is a distinct difference between the agriculturist and the farmer," he said. "The farmer makes his money on the farm and spends it in town, while the agriculturist makes his money in town and spends it on the farm. The farmer eats what he cannot sell; the agriculturist sells what he cannot eat."

Obituary

Chairman of William Jones, Limited, manufacturers of contractors' plant, etc., of London, W.C.1. MR. EDWARD PERCY JONES died on Saturday at the age of 70.

MR. CHARLES HAMILTON, foreman engineer at the Acklam works of Dorman, Long & Company, Limited, iron and steel manufacturers, etc., of Middlesbrough, has died at the age of 64.

MR. W. R. THANE, a founder member of the Midland branch of the Institute of Welding, has died at his Birmingham home at the age of 65. Mr. Thane was Midland area representative for Holden and Hunt, Limited, for 20 years and he was regarded as an authority on electrical resistance welding.

MR. F. H. ABRAHAM, of Mansfield, who died on November 19, 1951, at the age of 80, was well known to many connected with the foundry industry as managing director of the Standard Sand Company, Limited, which he originated. In 1934 this company amalgamated with the old-established Mansfield Sand Company to form the Mansfield Standard Sand Company, Limited, of to-day, in which he became co-managing director until his retirement three years ago. Apart from his wide knowledge of moulding sands and of Mansfield sand in particular, it may be remembered by older members of the industry that during the 1914-18 war he opened up quarries in Cornwall known as the Cornish Sand Company. From this source much-needed supplies of naturally-bonded sand were sent to the steel foundries in particular to replace the serious loss of Belgian sands upon which the steel trade was then so dependent.

News in Brief

F. & M. Supplies, Limited, 4, Broad Street Place, London, E.C.2, have appointed Industrial Products Company, 6, Holly Street, Sheffield, 1, as their agents in Yorkshire.

Contracts for the construction of the £2,000,000 factory at East Kilbride to be used by Rolls Royce, Limited, for the production of aero jet engines, have been secured by a number of Scottish firms. The major share of the work will be undertaken by Melville, Dundas & Whitson, Limited.

Mr. J. Kinsman has pointed out that the double-table shot-blast plant at Gailly Frères, referred to in the account of Foundries in the French Ardennes in our issue of November 15, is not in fact a Wheelabrator but a product of the concern with which he is associated—A. Sisson-Lehmann of Charleville.

Influenced by the desires of shipowners to have a product which will last the life of the parent vessel, the Glasgow engineering firm of Mechans, Limited, Scotstoun, who have a world-wide reputation for steel lifeboat construction, are now developing the use of aluminium alloy for this class of work.

North British Locomotive Company, Limited, Glasgow, are to build 100 railway engines for the South African Railways' new expansion programme. This has resulted in the heaviest orders in the history of South African Railways being placed this year—orders for steam and electric locomotives worth £22,000,000.

The first part of a report on researches into the phenomena of thermal radiation from flames, now being carried out at Ijmuiden, in Holland, under the auspices of the Flame Radiation Research Joint Committee, by a team of British, Dutch, French, and Swedish engineers and scientists, has just been published by the Institute of Fuel (Vol. XXIV, No. 140).

An Order indicating the scope of the Census of Production to be taken in 1952 for the year 1951, has been made by the Board of Trade. Undertakings producing coal, gas, electricity, oil shale, crude or refined petroleum or shale products are exempted from making Census of Production returns to the extent to which they supply the necessary information to the Minister of Fuel and Power.

The American-Canadian agricultural machine manufacturing company of John Deare & Company are opening administrative offices in East Kilbride where they are to erect factories to employ 3,500 men, women and youths. The company, one of the largest of its kind in the world, expects to occupy the first office premises next month. Mr. J. Wormley, managing director of the new works, has taken up residence in the new town, where he is to be joined by other key-workers early in the New Year.

Presiding officers of the International Foundry Congress at Atlantic City from May 1 to 7, 1952, will be Walter L. Seelbach, chairman of Superior Foundry, Inc., Cleveland, as president of the American Foundrymen's Society, and Guido Vanzetti, of the Milan Steel Foundry Company, Milan, Italy, as president of the International Committee. C. V. Nass, of the Beardsley & Piper division of Pettibone-Mulliken Corporation, Chicago, is the general chairman of convention committees as president of the National Castings Council.

A deal has just been completed in Keighley whereby Mr. W. Usherwood, of Wakefield, who 11 years ago founded the Grafton foundry in Waddington Street, Keighley, has now taken over the principal interest of Castle Foundry (Keighley), Limited, in the same town, which was formerly owned by Mr. A. Peckover. At Grafton foundry, Mr. Usherwood has converted a small workshop into one of the cleanest, most modernly equipped and efficient foundries in the area, and it is his intention to adopt the same policy at the Castle foundry.

After having been suspended for more than a year, work has been resumed on the extensions to the works of Stewarts and Lloyds, Limited, at Bellshill (Lanarkshire). The project, which will take about five years to complete, will add three new furnaces and two new tube mills to the existing four furnaces and one tube mill. Eventually the works will produce 6,600 tons of steel billets a week for processing in the tube mills, any surplus going to the company's mills in the west of Scotland. It is expected that the present labour force of 1,200 will be doubled to meet the increased capacity.

Under the chairmanship of Mr. Victor Yates, with Mr. Julius Silverman as secretary, the Birmingham group of Members of Parliament has announced that it proposes to investigate the whole question of iron and steel supplies in Birmingham, so many have been the complaints made to them about acute shortages. They plan to discuss the problem with local industrialists and trade union representatives and anticipate that their investigation will take place during the long Christmas recess, after which they will report their findings and conclusions to the Minister of Supply, Mr. Duncan Sandys.

At Hamilton (Lanarkshire) Sheriff Court recently, Colvilles, Limited, were fined £50, for an admitted contravention of the Factories Act, 1937, by failing to keep in position fencing round bevel gears. H.M. Inspector of Factories, who prosecuted, explained that a young employee had to have his right leg amputated below the knee after being caught in the machinery. For the respondents it was stated that safety officers were employed, but on the date in question excavations were taking place near the machinery and it was difficult to see whether the fencing was in position. The employee at the time of the accident, it was added, had no right to be where he was.

Many foundry firms in the Midlands, where the use of industrial safety clothing is extensive, are strongly supporting the campaign which Mr. H. C. Haselgrove, a Birmingham manufacturer of safety equipment, is leading to urge the Government to remove purchase-tax on protective industrial wear. Letters have been sent to 30 Members of Parliament to enlist their support and Mr. Haselgrove, who is a member of the National Union of Manufacturers and of the Birmingham Chamber of Commerce, states that he is acting as a spokesman for a large section of industry. Foundry managements have long deplored the imposition of tax on such essential safety wear as acid-proof aprons, rubber gloves, etc.

Employees from some foundries in the area are among the 120 power-press toolsetters who will attend the course believed to be the first of its kind in the world, at Birmingham University from December 17 to January 4, which has been arranged by the Midland Advisory Council panel on industrial accidents, in conjunction with the Factory Inspectorate and the Birmingham Industrial Safety Group. The course aims at training toolsetters in the prevention of accidents of the kind in which power-press operators are all too frequently involved and firms in the Midlands are loaning six different kinds of presses for demonstration purposes. The syllabus of the course covers the methods of guarding, tool-design and its influence on safety, guard-testing and setting. Each group of students will attend for two full days at the plant, which will be housed in the Mechanical and Engineering Department of the University. So many have applied to join this first course that a second will be held later.

Raw Material Markets

Iron and Steel

With orders plentiful for all types of castings, there is no difficulty in replacing completed work. The general engineering and speciality foundries, together with the light and jobbing concerns, given sufficient supplies of pig-iron and scrap, could be producing at capacity levels, but the present shortages are restricting outputs and, in some instances, are resulting in short-time working. The engineering and speciality foundries are the most seriously affected by prevailing conditions. They have extensive commitments for home and export.

No early expansion seems likely in the supply of low- and medium-phosphorus iron, and other grades, including hematite and refined irons, relieve the position only slightly. Any improvement in outputs of pig-iron have not yet benefited the foundries; their needs are not regarded as being so vital as those of the steelmakers, whose production continues to be seriously impaired by shortages of both pig-iron and scrap. The iron-ore position has continued to improve, and many blast furnaces have been enabled to obtain capacity production from existing units. This, it is understood, will be maintained provided ore shipments remain at present levels and that sufficient coke is forthcoming. The blowing-in of additional furnaces depends, of course, on increased supplies of raw materials, chiefly coke. The light and jobbing foundries need much larger quantities of high-phosphorus iron than are at present coming to hand. It is understood that a furnace now being relined and repaired in the Derbyshire area will restart at about the end of this month.

All foundries are in need of larger quantities of suitable cupola scrap in both cast iron and steel. Foundry coke is coming forward regularly, which is fortunate, as stocks at most foundries will not permit of any interruption in deliveries without entailing difficulties. Ganister, limestone, and firebricks can be secured to requirements.

The position at the re-rollers continues to be extremely difficult; short-time working is fairly general. Many mills have used up already their allocation of steel semis for Period IV from some home steelworks, and the commencement of work depends on the supplies they can secure from other producers, together with deliveries which are likely to come from abroad, although at present supplies from both sources are meagre. Deliveries of prime steel semis from home sources continue to be restricted, and the arisings of defectives and crops are consequently reduced. Many steelworks are finding it necessary to retain the defectives and crops on account of shortage of scrap.

All re-rollers are well supplied with orders. Heavy pressure is maintained for all sizes of sections, bars, and strip, and the re-rollers of sheets are inundated with orders, which are badly in arrears for want of sheet bars.

Non-ferrous Metals

Very steady conditions ruled on the tin market last week. There is no further news of the negotiations between the Reconstruction Finance Corporation and the Bolivian producers. For the present, at any rate, matters have reached the stage of stalemate. Doubtless the deadlock will be broken, but for the present both sides seem to be satisfied to await events. Stockpiling of tin in the United States has ceased, and the statistical position is deteriorating, since buying has been in abeyance for the past nine months or so.

In the United Kingdom stocks keep up to a reasonable level, but the fact that a backwardation is in existence on the London market indicates that stocks of metal on warrant are too low. Last week in the House saw a debate on the Supplementary Estimate for the trading activities of the Ministry of Materials. Nearly £20,000,000 was related to the acquisition of non-ferrous metals, including copper, zinc, and lead. It was stated that the Government hoped to build up stocks of these metals before the end of next March, but, of course, there is no certainty about this being achieved. In view of the extreme scarcity that exists to-day, it may well prove to be a difficult, if not an impossible, task. Lead is, perhaps, the most likely goal to be reached.

A good deal of interest was aroused last week by a report from the States that some 10,000 tons of aluminium from Canada were to be loaned to the United States in return for which a quantity of steel is to be allocated to Britain. Delivery of this 10,000 tons is to be spread over about five months and replacement is to take place from the U.S.A. at the end of next year. By that time it is anticipated that the American aluminium industry will have expanded to a point which will create a much easier supply situation.

As far as can be judged, this diversion of Canadian aluminium to U.S. consumers will not interfere with the Ministry's allocation to the industry here, the presumption being that the tonnage is coming out of stockpile metal.

Business in scrap is far from brisk and, as yet, there is no news of the new Order reducing the ceiling prices for secondary copper and fixing a ceiling figure for copper ingots.

London Metal Exchange official tin quotations were as follow:—

Cash—Thursday, £1,000 to £1,005; Friday, £997 10s. to £1,000; Monday, £975 to £980; Tuesday, £965 to £967 10s.; Wednesday, £960 to £962 10s.

Three Months—Thursday, £965 to £967 10s.; Friday, £967 10s. to £970; Monday, £950 to £952 10s.; Tuesday, £945 to £950; Wednesday, £945 to £947.

Latest Foundry Statistics

According to the October issue of the Bulletin of the British Iron and Steel Federation there was a slight reduction in employment in ironfoundries in September at 150,015 as the average weekly total employment on September 8 it was 73 less than a month earlier. The reduction in man-power was 118. However, employment was well up as compared with a year ago. There was a welcome rise in the average weekly production of liquid metal for making steel castings. At 10,000 tons it was 2,300 higher than August and 1,200 greater than a year ago.

The Ministry of Supply report that in September the production of aluminium castings was 6,122 tons made up of 1,604 tons of sand-cast components, 3,179 of gravity and 1,259 tons of pressure die-castings. The corresponding figures for the first nine months of this syear were 14,674, 29,000 and 8,798 tons.

FOUNDRYMEN will doubtless find much to interest them in the exhibition which the Birmingham Trades Council is organising at the Friends Institute, Birmingham, from December 4 to 8 as its Festival-Year commemoration, and which is intended to illustrate the story of trades-union progress. Sir Walter Monckton, Minister of Labour and National Service, is to open the exhibition, which is an ambitious effort, including a number of historic exhibits, such as a letter from Gladstone to Bradlaugh, the freethinker. Much union history was played out in the Midlands and the foundry trades made an interesting contribution.

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

(Delivered, unless otherwise stated)

November 28, 1951

PIG-IRON

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

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

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

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

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

Cold Blast.—South Staffs, £17 5s. 6d.

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

Spiegeleisen.—20 per cent. Mn, £22.

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

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered.)

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

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

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

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

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

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

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

Ferro-chrome (6-ton lots).—4/6 per cent C, £74, basis 60% Cr, scale 24s. 6d. per unit; 6/8 per cent. C, £70, basis 60% Cr, scale 23s. 3d. per unit; max. 2 per cent. C, 1s. 8½d. per lb. Cr; max. 1 per cent. C, 1s. 8¾d. per lb. Cr; max. 0.15 per cent. C, 1s. 9¼d. per lb. Cr.; max. 0.10 per cent. C, 1s. 9¾d. per lb. Cr.

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

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

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

Ferro-manganese (blast-furnace). — 78 per cent., £40 8s. 9d.

Manganese Briquettes (5-ton lots and over).—2lb. Mn, £50 6s. 6d.

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

SEMI-FINISHED STEEL

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

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

Sheet and Tinplate Bars.—£21 16s.

FINISHED STEEL

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

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

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

Tinplates.—52s. 1½d. per basis box.

NON-FERROUS METALS

Copper.—Electrolytic, £227; high-grade fire-refined, £226 10s.; fire-refined of not less than 99.7 per cent., £226; ditto, 99.2 per cent., £225 10s.; black hot-rolled wire rods, £236 12s. 6d.

Tin.—Cash, £960 to £962 10s.; three months, £945 to £947 10s.; settlement, £960.

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

Lead.—Good soft pig-lead (foreign) (duty paid), £175; ditto (Empire and domestic), £175; "English," £176 10s.

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

Other Metals.—Aluminium, ingots, £124; antimony, English, 99 per cent., £365; quicksilver, ex warehouse, £73 10s. to £73 15s.; nickel, £454.

Brass.—Solid-drawn tubes, 25d. per lb.; rods, drawn, 32⅛d.; sheets to 10 w.g., 29⅞d.; wire, 31½d., rolled metal, 28⅜d.

Copper Tubes, etc.—Solid-drawn tubes, 26d. per lb.; wire, 254s. per cwt. basis; 20 s.w.g., 281s. per cwt.

Gunmetal.—Ingots to BS. 1400—LG2—1 (85/5/5/5), £245 to £280; BS. 1400—LG3—1 (86/7/5/2), £260 to £300; BS. 1400—G1—1 (88/10/2), £330 to £360; Admiralty GM (88/10/2), virgin quality, £330 to £360 per ton, delivered.

Phosphor-bronze Ingots.—P.Bl, £340 to £370; L.P.Bl, £295 to £315 per ton.

Phosphor Bronze.—Strip, 38¼d. per lb.; sheets to 10 w.g., 40⅜d.; wire, 42½d.; rods, 38d.; tubes, 36½d.; chill cast bars: solids 4s., cored 4s. 1d. (C. Clifford & Son, Limited.)

Nickel Silver, etc.—Ingots for raising, 2s. 7d. per lb. (7%) to 3s. 6¾d. (30%); rolled metal, 3 in. to 9 in. wide × .056, 3s. 1d. (7%) to 4s. 0¾d. (30%); to 12 in. wide × .056, 3s. 1¼d. to 4s. 1d.; to 25 in. wide × .056, 3s. 3¼d. to 4s. 3d. Spoon and fork metal, unsheared, 2s. 10d. to 3s. 9¾d. Wire, 10g., in coils, 3s. 6¾d. (10%) to 4s. 6¼d. (30%). Special quality turning rod, 10%, 3s. 5¾d.; 15%, 3s. 10½d.; 18%, 4s. 2¼d. All prices are net.

Forthcoming Events

DECEMBER 3

Institute of British Foundrymen

Sheffield branch:—" Training and Development of Unskilled Labour in the Foundry Industry," by F. H. Hoult, 7.30 p.m., at the Sheffield College of Technology, Department of Engineering, Pond Street, Sheffield, 1.

DECEMBER 4

Institution of Works Managers

Wolverhampton branch:—" Re-equipment and Profits," by D. G. Petrie, 7 p.m., at the Star and Garter Royal Hotel, Wolverhampton.

Institute of Metals

South Wales local section:—" Solidification of Castings," by R. W. Ruddle, 6.30 p.m., at the University College, Metallurgy Department, Singleton Park, Swansea.

Institution of Chemical Engineers

" Design of Process Equipment with Special Hygienic Requirements," by J. Matthews, H. F. Goodman and G. H. Botham, 5.30 p.m., at the Geological Society, Burlington House, London, W.1.

Institution of Production Engineers

Reading section:—" Productivity and the Machine Tool," by N. Stubbs, 7.15 p.m., at the Apprentice School, Morris Motors, Limited, Cowley, Oxford.

Purchasing Officers' Association

Manchester branch:—" Any Questions," 6.45 p.m., at the Engineers' Club, Albert Square, Manchester.

DECEMBER 5

Institute of Welding

Symposium on " Recent Developments in Notch-bar Testing " jointly with the committee on Materials and their Testing, beginning at 10 a.m. at the Institution of Civil Engineers, Great George Street, London, S.W.1.

Institution of Works Managers

Notts and Derby branch:—" Economic Aspect of the Small Factory Competing with Larger Organisations," by A. H. Huckle, 7.30 p.m., at the Welbeck Hotel, Nottingham.

Manchester Association of Engineers

Students' section:—" Grinding and Grinding Machines," by G. H. Asbridge, 7 p.m., in the Engineers' Club, 17, Albert Square, Manchester.

Purchasing Officers' Association

Tyneside branch:—" Activities of the Industrial Recovery Advisory Council," by T. Stonehouse, 7 p.m., at the Crown Hotel, Newcastle-upon-Tyne.

Institution of Production Engineers

Wolverhampton section:—" Budgetary Control and Standard Costs," by F. Hunter, 6.30 p.m., at the Star and Garter Hotel, Wolverhampton.

Incorporated Plant Engineers

Southampton branch:—" Selection of Motor and Switchgear," 7.30 p.m., at the Polygon Hotel, Southampton.

DECEMBER 6

Institute of Metals

Leeds Metallurgical Society:—Films: " Process Heating Equipment," 7 p.m., at the Chemistry Department, The University, Leeds, 2.

Institution of Production Engineers

Cornwall section:—" Mechanical Handling and Work Movement," by J. Bright, 7.15 p.m., at the School of Metalliferous Mining, Camborne.

Manchester graduate section:—" The Corby Iron and Steel Works of Stewarts and Lloyds, Limited," by E. A. Taylor, 7.15 p.m., in Room C3, Reynolds Hall, College of Technology, Manchester.

Incorporated Plant Engineers

Peterborough branch:—" Fire Prevention for Engineers," at the Eastern Gas Board's Demonstration Theatre, Church Street, Peterborough.

DECEMBER 7

Institution of Mechanical Engineers

General meeting:—" Measurement and Interpretation of Machinery Noise, with Special Reference to Oil Engines," by C. H. Bradbury, 5.30 p.m., at Storey's Gate, St. James's Park, London, S.W.1.

Institute of Metals

Sheffield local section:—" Precious Metals in Industry," 6.30 p.m., at the University, St. George's Square, Sheffield.

DECEMBER 8

Institute of British Foundrymen

East Midlands branch:—" Synthetic Resin Corebinders," by G. L. Harbach (joint meeting with the Lincolnshire branch), 6 p.m., at Nottingham.

Newcastle branch:—" Production of Heavy Castings for Electrical Generating Equipment," by N. Charlton, 6 p.m., in the Neville Hall, Westgate Road, Newcastle-upon-Tyne.

West Riding of Yorkshire branch:—" Design of Iron Castings," by K. H. Collinson, 6.30 p.m., at the Technical College, Bradford.

Manchester Association of Engineers

Conversazione, 6.45 p.m., at the College of Technology, Manchester.

NOTICE

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

SITUATIONS WANTED

FOUNDRY Plant Development Engineer, young and energetic seeks post as WORKS ENGINEER or similar executive position. Investment considered.—Box 1409, FOUNDRY TRADE JOURNAL.

PURCHASING EXECUTIVE (42) seeks change. Twenty years' experience all ferrous and non-ferrous foundry raw materials and equipment. Excellent connections at high level in all branches of the industry.—Box 1405, FOUNDRY TRADE JOURNAL.

YOUNG FOUNDRY TECHNICIAN, 10 years' practical and technical experience, desires position in South Africa, Australia or New Zealand. Sound knowledge of gating and risering techniques, alloying, melting and refining. Cupola practice. Sand and metal control.—Box 1406, FOUNDRY TRADE JOURNAL.

FOUNDRY/GENERAL MANAGER (45), life experience, desires change. Twelve years' managerial, light and heavy jobbing grey and high duty, non-ferrous and light alloy. Semi and fully mechanised plant layout. Sand control and Met. proven record, lecturer Foundry practice. Sales, commercial connections, three years' consulting capacity abroad. Salary £1,500-£2,000, with prospects of Directorship. Not afraid of hard work.—Box 1414, FOUNDRY TRADE JOURNAL.

VITREOUS ENAMELLING AND FOUNDRY TECHNOLOGIST with good academic qualifications and 25 years' responsible, practical and technical experience in manufacture of Light Castings (Baths, Cisterns, Stoves, Pipes, etc.) and an expert knowledge of all Dry process and Wet process Enamelling on Cast Iron and Sheet Metal, desires position in a temporary, permanent or advisory capacity. Ability and experience to get results. —Box 1413, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT

FOUNDRY FOREMAN required for Malleable Foundry. To control foundry and ancillary departments. Must have sound experience of jobbing and repetition moulding, coremaking and production control. Good disciplinarian. Excellent future prospects. Accommodation available. Write with full details of training, experience and present salary to—Box 1367, FOUNDRY TRADE JOURNAL.

NORTH-EAST COAST Steelfounders have vacancy for Young Man with laboratory training and experience electric arc furnace. Good prospects to young man of intelligence and ability.—Apply, giving educational and employment history, age, married or single, and salary required, to Box 1403, FOUNDRY TRADE JOURNAL.

FOUNDRY SHIFT FOREMAN required by Non-ferrous Refiners, Billet and Ingot Manufacturers, in Birmingham area. Commencing salary £550. Applicants should be capable of supervising all labour and controlling Electric, Coal and Oil Fired Furnaces. Full particulars in confidence.—Box 1404, FOUNDRY TRADE JOURNAL.

SITUATIONS VACANT—*Contd.*

NON-FERROUS AND CAST IRON MOULDERS required. Good rates. Canteen, etc.—Apply S.E.M., Pitsea Street, Stepney, E.1.

ENAMEL PLANT SUPERINTENDENT of proved efficiency and skill required. Sheet and cast iron. Progressive position and excellent prospects. Starting salary £1,000 for right man.—Box 1415, FOUNDRY TRADE JOURNAL.

FOUNDRY in S.W. Suburban London requires energetic young Man (about 20 or 30) with metallurgist or technical training to take charge as FOREMAN in small non-ferrous department, where a wide variety of alloys are used.—Apply Box 1399, FOUNDRY TRADE JOURNAL.

FOUNDRY FOREMAN for Non-ferrous Foundry (London area), must be fully experienced and highly skilled in the production of Bronze and Aluminium Castings to specification, and the mixing of all Non-ferrous alloys. Applicants please state experience in detail, age and salary expected.—Apply Box 1392, FOUNDRY TRADE JOURNAL.

TIME STUDY AND RATEFIXING ENGINEER required for modern engineering factory near Leeds. Foundry experience an advantage. An excellent opportunity for a capable man.—Apply, giving full particulars of age, experience, qualifications, and salary required, to Box 1384, FOUNDRY TRADE JOURNAL.

ASSISTANT FOREMAN, to act as Chief Inspector of castings in a mechanised foundry in Midlands. Staff position. Preference given to applicants with pattern-making or machine shop experience.—Reply, giving full particulars of experience and salary required, Box 1380, FOUNDRY TRADE JOURNAL.

MANAGER (British by birth) required for Metal Powder Plant in East London. Candidates should preferably, but not necessarily, be engineering or metallurgy graduates, with Foundry Management experience. Salary according to qualifications. Good prospects. Superannuation Scheme.—Write full details to Ref. S.M.P., Box 5431, c/o CHARLES BARKER & SONS, LTD., 31, Budge Row, London, E.C.4.

CHARGE HAND required. Good wages and permanent position, required to work on floor under present Foreman shortly retiring. Must be capable of moulding all normal work found in Jobbing Foundry. Living allowance paid extra until suitable accommodation found. Write in first instance stating age and experience to—THOMAS LAKE & CO., LTD., Newport Foundry, Barnstaple, North Devon.

MESSRS. PETER BROTHERHOOD, LTD., Engineers, Peterborough, require the services of a First Class FOUNDRYMAN with a general technical background to take charge of their Iron Foundry under the Works Director. The foundry is employed on high class pressure castings of a general engineering character. The selected applicant would be invited to become a permanent member of Works Staff where a pension scheme is in operation. A Chemist and Metallurgist is employed.—Apply in writing to: DEPUTY WORKS DIRECTOR, giving age, experience and salary expected.

SITUATIONS VACANT—*Contd.*

PLANT DRAUGHTSMAN required for Foundry Plant Development Scheme. Good opening for right young man. Please state age and experience. — CONEYGRE FOUNDRY, LTD., Tipton, Staffs.

METALLURGICAL CHEMIST required for Malleable Foundry, with experience of melting and annealing.—Apply, stating age, past experience and salary required, to BAGSHAWE & CO., LTD., Dunstable Works, Dunstable.

WORKS CHEMIST required to take charge of laboratory and test house. Completely Non-ferrous Sand and Gravity Die Castings. Must be approved and have complete knowledge of A.I.D. procedure. Knowledge of radiology and the interpretation of X-ray photographs an asset.—Box 1411, FOUNDRY TRADE JOURNAL.

THE BRITISH CAST IRON RESEARCH ASSOCIATION is extending its Operational Research Team and invites applications for two vacancies from those experienced in foundry operations affecting production. Salaries in accordance with training and experience. A memorandum on the appointments is available from, and applications (which will be treated in confidence) should be made to the SECRETARY, Bordesley Hall, Alvechurch, Birmingham.

VITREOUS ENAMELLER. — Experienced Enameller required for small Factory in Johannesburg, South Africa. Only experienced men need apply. Good salary and excellent prospects for the right man.—Apply in the first instance, giving full particulars of experience, age, and copies of references, to Box 1408, FOUNDRY TRADE JOURNAL.

FOUNDRY MANAGEMENT. — The Stanton Ironworks Company, Limited, near Nottingham, requires an ASSISTANT FOUNDRY MANAGER, aged between 35 and 45, with sound technical and practical Grey Iron Foundry experience covering both floor moulding and mechanised plant. The post is superannuated and progressive. Write to the STAFFING OFFICER stating age, whether married and full details, in confidence, of present post, education, technical training and experience.

STEEL FOUNDRY ASSISTANT MANAGER (Yorkshire Area), 30-40 years of age, required to superintend production of approximately 3,000 tons per annum of jobbing and machine moulded castings. Applicant must be thoroughly practical; he will be in charge of all stages of production and responsible to the Director in control of the foundry. House will be provided if necessary, and position will be superannuated. Applications will be treated with complete confidence. State age, training, previous experience, positions held, and salary required.—Box 1391, FOUNDRY TRADE JOURNAL.

BUSINESSES FOR SALE

FOR SALE.—Small Brass Foundry, East Lancs, district, good connections, continuous runs, plenty of scope.—Box 1410, FOUNDRY TRADE JOURNAL.

FOR SALE AS A GOING CONCERN.—Old-established Foundry, 11 miles from Central London. Producing high grade Bronze and Aluminium Castings for all branches of engineering industry.—Replies to Box 1395, FOUNDRY TRADE JOURNAL.