Defects in Automobile Grey-iron Castings

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The first part of this article was published in the last issue of the JOURNAL and the Author's treatment of the subject is completed here with a thorough examination of the types of defect that arise in iron foundry practice. The Writer's experience is related to problems that have arisen in the course of automobile casting production, but it will be readily conceded that he has covered a very wide range of fault—even if it is not claimed that his treatment is exhaustive. In dealing with a foundry making castings continuously at a high rate of production with mechanized moulding machines, process control, the establishment of optimum production conditions and the maintenance of those conditions by strict supervision, receives great attention and emphasis in the text. Continuing his analysis of specific faults and their correction the Writer considers the following topics: Cold-shuts; slag inclusions; blow-holes; pinholes; cuts and washes; rat-tails and scabs; "drops"; "rats" and crushed swells; sand-inclusions; shifts; run outs; rough castings; and dimensional inaccuracy. The final subject dealt with is quality control, in which is outlined a regime of stage-by-stage inspection, and the article concludes with a brief reference to statistical methods.

In the previously published section of this article the Author drew attention to the fact that it was in the techniques concerned with the various aspects of the moulding process—metal, sand, foundry practice and the state of the equipment—that one must look for the origin of castings defects. The kind of questions that have to be asked by foundrymen to guide them to the source of trouble, was presented. Fifteen specific types of fault were listed and the detailed analysis of three of these, together with a discussion of corrective measures, occupied the earlier section of the article. Those dealt with were shrinkage and draw, cracked castings and hard spots. This concluding part of the article begins with a consideration of cold-shuts or laps.

"Cold-shuts"

Cold-shuts are areas imperfectly coalesced in one or more places and are formed by the failure of metal to fill up the mould perfectly. The unfilled areas often appear as rounded. The factors contributing to the formation of cold-shuts are noted in the following: on the basis of which various preventive measures are suggested. It is essential to take measurement of the temperature of every ladle tapped prior to the pouring of moulds. In addition, the number of boxes poured should be carefully controlled in the light of the progressive drop of metal temperature. The causes and symptoms of unfilled moulds are dealt with in the following.

Cold Iron

Cold iron emanates from low pouring temperature (see Fig. 12). The surface is characterized by very smooth shiny appearance without showing any sign of imprint of sand and fracture faces always show the presence of chilled edges. Iron low in fluidity exhibits similar features.

Improper Gating

Bad gating may choke up the flow of metal forming a cavity. Fig. 13 shows an unfilled casting due to the ingate being placed wrongly. Fig. 14 shows "lap" induced by defective gating technique. It was prevalent in all castings and occurred at similar positions with respect to ingate. The surface clearly indicated the imprint of sand all around and did not exhibit a smooth appearance of cold metal. Inadequate cross-section of gating combined with gas shows shiny edges or lap at remote ends. Proper venting may remove these laps.

Pouring and Double Teeming

Interrupted or slackened pouring may produce lap due to oxidized layers not fusing and shows the imprint of the sand. The lap arising from double teeming appears all around level with the oxidized unfused layer.

Gas

The presence of gas in metal reduces surface tension and a ladle addition of Ti, silicon carbide or even politing produces effective scavenging action. The symptoms are round or oblong holes with the imprint of the sand pattern on mould face often with globules of blown-out metal. The fracture faces show an absence of chilled edges.

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Fig. 12.—Cold shut due to low pouring temperature of metal, showing the characteristic smooth, shiny surface appearance.

**Running**

Hard running and very quick pouring result in entrapped gases that prevent the formation of a continuous flow of metal producing lap or cavities with the same symptoms ensuing as described in previous paragraph.

**Shift**

Cope, drag or core shift, or even the use of twisted cores produces uneven wall-thickness, lap, or even a cavity resulting in an unbalanced area producing cold shut. The surface around appears rough with the imprint of moulding sand, core-sand, or a fine smooth surface with mould or core wash. Such defects accompanied by the use of old core material, with more combustibles or absorbed moisture, may even show shining spots with lap due to the shift restricting the free flow of the metal.

**Wash**

Wash effects emerge from the use of too fine a sand which reduces fluidity. In thin-sectioned castings covered by cores with thick graphite wash, non-coalesced layers of metal give rise to cold lap or cold shut, if the metal in the feeding head or its temperature is low. This is relative to the area to be covered, the position of the ingate and the area of ingate.

**Slag Inclusions**

A casting may be lost due to the presence of slag or undissolved incoherent. Slag inclusions will show up on the surface of a casting in the vicinity of gates, or as trapped along the line of flow of metal. The slag inclusion gets dislodged during casting, leaving behind rounded cavities of irregular shape. They are caused by the following factors:

**Metal**

Slag may arise in pouring from poorly skimmed metal or the use of a ladle containing entrapped slag; the formation of dress from ladle addition; the use of an old ladle and too slow a pouring rate, i.e. the pouring cup is not maintained full whereby slag particles are not held up in the cup but pass into the casting along with the stream of metal.

**Sand Condition**

The formation of cinder-like slag is engendered by the use of moulding material having too low a(319,910),(999,999)
head; failure of vent pockets; insufficient venting and wet pouring basin.

Core Blows

Core blows are rounded cavities often showing the imprint of core faces and are caused by the use of: Hard or insufficiently-baked cores; sea coal in the mixture—exhibiting a coating of black shiny flake carbon; incorrectly-vented cores where core-inits obstruct the vents; wet or oxidized chills; carelessly patched cores; sand with permeability too high or low; core paste either too thick or too wet causing the metal to boil; core wash not properly dried, and cores which have absorbed moisture after being stored for a long period and used without reheating.

The isolation of the defect needs faithful recording of data. This includes all such facts as the batch of the sand mix, making size and shape of vents appropriate to the cores, baking time and temperature of cores, position of patching of a repaired core prior to the closing of a mould or core set-up; location of the occurrence of defects in castings and the date; the identification marking of all important cores and other different processing in stages, etc. Remedial measures are based on the findings of all these records.

Pinholes

Pinholes appear as pitting on the surface of castings. Their occurrence in relation to the core or mould sand face indicates whether they have been formed from gases released coming out of a core not properly baked or moulding sand with too high a moisture content, or sea coal. The presence of aluminium in metal also promotes their formation but will effect all castings poured from a particular heat. In hyper-eutectic composition, kish may cause porosity which may be eliminated by reducing carbon and balancing the composition by increasing silicon. In addition to the use of correctly baked cores, and proper moulding sand, the increase in temperature of the metal with wider ingates may assist, in certain cases, in avoiding the formation of pinholes.

Cuts and Washes

Cuts and washes appear as rough lumps of metal or sharply-defined rounded corners and may show granular depressions or holes along the flow of metal. The causes of these include soft ramming with its attendant swells and metal accumulation due to washings of sand; low moisture; low green strength and type of clay bond used; pouring metal directly into the sprue and pouring from too great a height. Improper gating will give rise to a “nozzle effect” causing a large volume of metal to flow over sharp corners or projections of the mould face.

Rat-tails and Scabs

Buckles and scabs occur in the cope side close to the ingates while rat-tails appear furthest away from gate. These are produced when the condition of the sand, the pouring temperature of metal and the section thickness of casting are such as to cause enough expansion in the mould face to make a small ridge of sand on the mould face. Buckles, scabs and rat-tails may occur simultaneously in thick sectioned castings, e.g. 18-in. dia. by 2-in. thick, gated to pour within 16 to 18 sec. The conditions favouring these defects are hard ramming or the following sand conditions—low permeability, high moisture, high strength, low sea-coal content and a change in the type of clay used.

The expansion of moulding sand may be reduced by an increase in grain size, the reduction of fines, the addition of combustible materials, reduction of mould hardress, increase in permeability, reduction of moisture content, change of gating system and change in ingate area.

“Drops,” “Rats” and Crushes

Drops

Drops appear as large lumps of metal protruding above the normal surface along the line of flow of metal.

Rats

Rats occur when part of mould face sticks to the pattern. This may be due to: sand condition—low green strength or low or high mould hardness;

Fig. 13.—Graphic illustration of an unfilled mould arising from the ingate and feeding head being wrongly placed. (a) Incorrect placing and (b) normal (correct) position.
plant condition—not enough draft on pattern; moulding machine drawing too fast; loose pattern; worn out bearing surfaces of the flask or worn out or dirty pattern and worn bumping pad on the moulding machine.

Crushes
Crushing denotes a deformation along the parting-line or around core-prints. It may be formed by: low green-strength of sand; the core-print being too large for the pattern print; closing not being attended to properly; mismatching of the cope and drag pattern; incorrect mounting of the pattern; core print being too small for size of core; improper clamping of the mould; use of too heavy a weight; worn stripping-plate on moulding machine; improper bedding of moulds on bottom plates or boards and conveyer plate carrying the closed mould knocking due to the sticking of its wheels, thus causing jekks sharp enough to cause a shift or sand drop.

Swells
Swells occur due to the displacement of sand by metal and are formed by: (1) Soft ramming of the mould due to insufficient jolting or squeezing; (2) an improperly bedded bottom-plate or mould; (3) lack of flask rigidity, i.e., insufficient reinforcement bars; (4) a ram away caused by the machine jolting off centre or the pattern being off-set; and (5) a weak sand lacking in green or hot strength.

Sand Inclusions
Of the major factors causing rejections sand inclusions are prominent. They appear as cavities of irregular size, the inner surfaces of which show the imprint of granular material. Generally they arise from the following factors: from moulding practices; the soft ramming of moulds; the grinding of cores over an open moulding box; dislodging of moulding sand during core setting; core ends broken during setting—particularly sharp ends, if over-baked; sand dislodged during closing of moulds; inadequate cleaning of moulds prior to closing; from sand from cuts and washes—or mould crush—being entrapped in the castings; from incorrectly conditioned sand or sand containing foreign materials in sand. From the core condition: Soft or over-baked cores, or those with thick castings of wax; wash not properly controlled; under-baked or low strength cores causing wash out; repaired cores not properly dried. From improper gating leading to the metal impinging on green moulding sand or a green core. From too fast pouring or from a height giving rise to positive ferrostatic pressure.

The cause of sand inclusion requires a thorough examination of the casting that may include examining the sand inclusion under a low-powered microscope to ascertain whether it is from moulding sand—being coarse in texture and dark in color; or core sand—being finer and shiny in appearance; or whether it is entrapped accumulated wash sand or clay roll—being very fine and cindery in appearance. It remains to be said that it is rather difficult in practice to prevent sand inclusions altogether owing to the intensive supervision involved.

Shifts
Shift occurs when the cope or drag does not exactly match at the parting line (refer Fig. 16) while core shift results in the production of unequal thicknesses of walls or even in some cases to united wall. These may occur as result of: Worn out pins and bushings; cope and drag pattern not exactly matching; insufficient or loose clamping; core, incorrectly set, twisted, or not properly repositioned; lack of ample core prints or charpels; lack of proper support of core at critical places with perhaps over-small charpels causing early melting; badly-designed ingate system causing core lift and a slow pouring rate may also cause core lift, or, because of the slow rise of metal, excessive heating occurs prior to the core being covered and a part of it cracks off.

Run-outs
Run-outs describe the molten metal leaking out of some part of mould cavity while pouring, or just after pouring is completed, and they are formed by: Soft ramming between the mould cavity, sprue or runner and the edge of the flask; the mould not being properly bedded or rammed hard around; insecure clamping, loose pins, worn out bushings, and, in the extreme cases, omitting to use clamps altogether; the bearing surface for the flask on the pattern being worn out or not properly cleaned; sand or metal sticking on the joint of the flask; the use of warped or even hot boxes (clay rolls are often employed to adjust box irregularities); the twisted and bent core for the casting; the sprue being too near the side or the runner too near the joint of the flask; vents being too close to the core since the mould cavity particularly if provided through the sides of the flask or bottom plates and the use of broken cores causing metal penetration and connection with the core vent. The major causes of run outs arise from equipment which should be checked at regular intervals and all defective units eliminated. Processes of core-setting and core and core box selection should be provided to prevent run outs.

The causes of separation defects in exception of the following:

Molding Sand
Sand or its following is usually the most important factor; is the pressure on a too-tight or too-loose core; the temperature of the sand; and being dry or being properly mixed. The following factors affect the surface appearance of the casting. A poorly mixed moulding sand generally melts in a way that gives a too-tight or too-loose core and it is generally sprayed with water. A properly mixed moulding sand is generally sprayed with water over the sand, which is then blown dry. The following factors affect the appearance of the casting. A poorly mixed moulding sand generally melts in a way that gives a too-tight or too-loose core and it is generally sprayed with water. A properly mixed moulding sand is generally sprayed with water over the sand, which is then blown dry.

Gating System
A properly designed system of gate, runner and risers generally melts in a way that gives a too-tight or too-loose core and it is generally sprayed with water. A properly designed system of gate, runner and risers is generally sprayed with water over the sand, which is then blown dry. The following factors affect the appearance of the casting. A poorly designed system of gate, runner and risers generally melts in a way that gives a too-tight or too-loose core and it is generally sprayed with water. A properly designed system of gate, runner and risers is generally sprayed with water over the sand, which is then blown dry.
defective units either scrapped, or rectified before use. Progressive supervision during mould-closing, core-setting and venting and a careful watch on minor details will entirely prevent the occurrence provided that sound equipment is used.

Rough Castings

The chief factors producing rough castings are dependent on sand condition, moulding practice and in exceptional cases on metal temperature.

Moulding Sand

Sand condition may be at fault in any of the following respects: Having high moisture or permeability; low flowability, e.g., high-strength low-moisture sand containing lumps of coal, slag, metal shot, etc.; being low in coal content or too coarse, and being insufficiently replenished with fresh sand.

Moulding Practice

The following faults in moulding practice can affect surface appearances: The mould being soft-ramped through poor jolting, low-operating pneumatic pressure, or not enough draw in pattern for machine moulding; the use of hot sand; low mould hardness particularly at vertical walls, or on inclined faces and incorrectly sprayed moulds. The condition of the core will determine internal surface finish and is adversely affected by: The use of too coarse a sand; a too-rapidly-baked core; soft ramming or an inadequately blown core producing soft spots and porosity; an incorrect coating mixture, incorrectly sprayed, dipped or coated and blowing vents not equally distributed in relation to section thickness or cores.

Temperature

A pouring temperature that is too high for the moulding materials produces a bad surface. This generally results in burnt and sandy appearance all over the surface of the castings.

Gating System

Rough sandy appearance in the vicinity of ingates due to impinging action of metal, etc.

In order to prevent rough castings, the things to watch are: (1) the quality and grade of sand—

including coarse-to-fine ratio; (2) regular replenishment of system sand; (3) conditioning of sand; (4) uniformity of ramming with the use of the squeeze board and checked by mould-hardness test; (5) pouring temperature and (6) the gating system.

Dimensional Inaccuracy

Automobile castings are mass-production items whether in the foundry, machine-shop or assembly line. Automatic high-speed machines with multitools are used for machining castings which are clamped or positioned for the first operation with respect to particular location points. Any slight variation or shift in position either due to warpage, core shift or pattern equipment, leads to the production of scrap castings. Dimensional inaccuracies produced by moulding methods may be grouped as those affecting: (1) Wall-thickness; (2) overall length and width or (3) those affected by subsequent processing operation.

Wall-thickness

Variations in wall-thicknesses occur through: Worn out core boxes or patterns; too much rapping of the pattern or core-box before or during drawing; cores not being true to boxes—through not using properly-designed supports to prevent sagging while baking and handling; pattern not being mounted properly; springing of the pattern; cores not being jigged or assembled correctly and improper setting of cores.

Length and Width

Variations in overall length and width arise from:

Excessive rapping of pattern; non-uniform shrinkage of metal; castings becoming elongated in one direction due to movement being restricted by thick fins, etc., producing a shift in the location of drilling points.

Processing Operations

The processing operations on castings cause dimensional variations due to: excessive handling, shot-blasting or grinding; warping through casting being shaken-out too soon or improperly supported during heat-treatment; warping as a contraction defect in plate-type castings with ribs which make it

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**Fig. 15.—Three examples of the occurrence of blockholes that came to light in partially-machined grey-iron castings.**

The faults arose respectively from: (a) The moulding sand; (b) the core and (c) inadequate centring.
to pouring, as follows: Control of raw materials and scrap with regard to their purity, size, suitability of composition, etc.; control of the charge and melt ensuring its adherence to specified composition, by the chill-test, control of combined iron and other elements and check on oxidation; temperature of bath; control of the pouring operation in respect of inoculation (size, quality and time lag between inoculation and last box poured); chill depth; alloying elements (quality and size); pouring temperature; rate and height; use of feeders (type, quality and time); slag-free pouring (spout ladles and skimming) and the use of green ladles (the use of wet sand for the repair of ladles and spouts is to be avoided).

These comprehensive aspects of metal-control generally take care of cold-lap, chilled edges, hard spot, blow-holes, slag inclusions, rough castings and shrinkage.

**Sand**

Sand control falls under three headings, here listed, with the respective properties that have to be checked: Raw materials with respect to their purity, grain-size distribution, shape, fineness, clay-content and refractoriness; sand mixes for system sand for moisture, size-grain, permeability, green-strength, combustibility, replenishment by new sand and dry-strength; due consideration must be accorded to the optimum time lag between preparation and use and test-samples should be taken from the moulding station: Core-sand mixes with regard to moulding station: Core-sand mixes with regard to—accurate weighing of each type of sand, ensuring that all dry additions are made first, e.g., clay, dextrose, etc., and liquid additions last; maintenance of complete records after each addition (with time); control of each batch preparation of the mix, with the aid of an automatic timer, using a standardized cycle for mixing; colouring of sand for important cores such as for water jackets, bores, water divisors, etc.; observance of the correct time temperature between the preparation of the mixture and its use; maintenance of the proper core-baking time, temperature, atmosphere of the oven and uniformity of heating; control of thickening of the mix by varying the temperature of the oven; and determination of the quality of the gum paste (fine silica flour may be added to increase refractoriness); adequate drying of cores and moulds; the application of the various control tests for core-sand mixes including hot-breaking strength and appropriate corrections for seasonal changes.

This regime of control generally eliminates sand, drop, ractails, scabs, blowholes, pinholes, gas-lap, rough castings, sand inclusion, core and washes, core-blow and hot cracks due to non-collapsibility of cores. In the case of important cores, each core as made from a particular batch mix of sand may be identified with special colours or marks and may be correlated with the casting produced by maintaining suitable records at each stage of processing by the use of process-control cards.

**Inspection Control**

A routine for the supervision of patterns and equipment should follow some such scheme as that briefly described.
Patterns

All new pattern equipment should be thoroughly checked as per the method drawing and in the event of any modification being made, the set should be re-examined: Routine inspection of all patterns should be carried out at regular intervals for dimensional accuracy, wear and tear, correct size of sprue, runners, ingate, feeding heads, etc.; after any modification or rectification a further check should be made; for any new pattern, sample castings should be made and thoroughly checked and if found satisfactory the pattern may be passed for routine production; if necessary ingating system may be modified to take care of defects in castings which may include introduction or modification of shrink holes, risers, vents, core points, etc.

Moulding Equipment

Inspection of moulding equipment must ensure the proper dimensions of each and every box used. The bearing surfaces, pin and bush sizes, ovality, matching faces and boxes, flash bars with respect to feeder holes, ingates and vents, core sprue needs to be examined at regular intervals. Only those boxes which are completely sound and true should be accepted and all bent boxes, or boxes with bent and worn out bars rejected. Jig elements used for checking cores, template gauges and other gauges for indicating reference points, need inspection. Moulding machines should be examined for proper mounting of the pattern and uniform clamping.

Core Egn: moist

Core equipment to be viewed at regular intervals includes all dryers, inserts, core-blower heads, core carriers, venting rods (for desired length and size), stripping plates and boxes; disintegrated and worn-out plates should be removed after weekly checking and re-inspection, after any modification, prior to returning to the system; sand-blowing holes and heads should be checked to avoid air leaks (to prevent soft and spongy spots in cores); a check must be carried out for worn-out points or mis-alignment of jigs used for cores checking.

Production-process Inspection

Inspection during production is one of the vital factors in maintaining the consistency of operations necessary to keep down rejections. Breaking down the various aspects of the production process a programme of inspection along the lines described should be carried out.

Pattern

Each pattern, prior to set-up, should be checked for ingate and sprue sizes, and other critical dimensions. After every set-up of a new pattern a check should be carried out with jigs and other gauges. Firstly the mould as-closed is checked by proper marking. When this is found satisfactory, moulds may be made for production. Inspection of the first-off castings right in the pouring zone, is desired wherever possible, before permitting regular production to ensure against major defects such as core shift, faulty feeding, mismatch, blow-holes, cold-shut and other defects, etc. In the event of the castings being found defective, the casting with its feeder-head and ingate is examined and the pattern is withdrawn for further modification of foundry technique. Subsequent repeat inspection of the modified pattern and the castings produced from it should then be carried out.

At the beginning of every shift the first box needs to be opened, preferably at the pouring end, the casting examined for rough dimensional accuracy and such casting defects as wrong wall thickness, mismatch and core shift. Production may be resumed when the casting appears satisfactory. Similarly whichever a pattern is replaced by another set of patterns for another casting, the first box should be opened and the casting inspected.

Cores

Cores must be checked for dimensional accuracy by template gauges observing 100 per cent, for imporium cores and 10 per cent, for other cores on a random sampling from each batch from a particular sand mix; baking time, temperature and uniformity of heating should be watched to prevent buckling. Other features where faults might lead to trouble are: Venting and the size of vents; surface and other defects; proper drying of repaired cores; size, shape and method of insertion of core rods; gum paste, that should be non-moisture absorbent with resin soluble in alcohol; the time of application and proper draining of the wash or backing mixture applied, its uniform thickness and freedom from globsules—with intricate cores special care is needed to obviate low wall-thickness; on instances of variation in dimensions arising from angular cores, it is essential to inspect core-dryers and plates to isolate defective ones; core-assembly moulds should be checked by proper jigs and washburn cores examined for over-baking of their edges.

Moulding

The main factors to be ensured by inspection during moulding are as follows: Uniformity of ramming—number of hits, pneumatic pressure—to achieve uniform mould hardness; adequate squeezing bearing in mind that in some cases it may be necessary to squeeze in two stages to make the mould hard in a particular zone; accurate jiggling of core assemblies; use of cores of proper ovality, avoiding soft cores as tested by the nail-scratch test prior to set-up in the mould; cleaning prior to set-up of cores to the closing of boxes; proper size of bush and clamps and rigid clamping; adequacy of venting; use of strainer cores of appropriate strength and ingates, feeder heads and runners of suitable dimensions; that chills and chaplets of the correct sizes are in the dry-coated condition, careful use of putty so that it does not become an inclusion in the casting; particular attention to minor points during the closing of the mould to avoid core-shift, sand-drop, uneven wall thicknesses, etc. and draw-everything mould hardness at critical places and ramming in instances of the use of composite sand mixes at corners, etc.

Shake-out

At shake-out a routine check should be carried out on the first casting from the beginning of every shift and from every set-up of a new pattern, all obviously defective castings should be rejected at this stage; an occasional inspection of ingates, sprues, runners, feeder heads, ought to be observed and a complete
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dimensional check-up of castings drawn at regular intervals from the production of each shift, in case the whole batch is spoiled.

Casting

During setting the opportunity should be taken to segregate castings with major defects. Supervision should ensure that castings are not lost through the process itself—e.g., chipping, hammering, etc.—in which connection scrutiny of tools is vitally important. To find the bluntness of chisels, appropriate usage of lead, copper or aluminium, hammers, weights of hammer heads, shape of grinding tools, soundness of tool rests, careful handling, etc., to avoid loss due to over-grinding, and breakage of fins; troublesome features include the cleaning out of cores, removal of core wires, and rods, particularly from water-jackets and tool-thick feeders, the removal of which can cause the breakage of castings.

Finished Castings

Inspection of finished castings involves a regime of major examination including complete dimensional check-ups of sample castings, including the marking up of random castings taken from each day's production, and the application of template gauges to all major dimensions; the checking of location points on castings to be used as reference points for feeding automatic machines; the clearing out of surface defects and the occasional sectioning of castings for inspection, breakage and shift, wall thickness, etc., in inaccessible positions and complete cleaning of water-jacket channels.

Statistical Quality Control

The results of metallurgical control and inspection at various stages should be carefully recorded with all details, although avoiding unnecessary paper work. These are later statistically computed and control limits are worked out for the consistency of process, including upper and lower control limits for average and range charts. Histograms with sigma (σ) and mid-average values (μ) are computed; casting-wise for hardness values, etc., with a high deviation of specific core, mould, and occurrence of defects. Each defect as it appears is analysed in the SOC technique and action taken for process deviation together with enough preventive measures including rigidly avoiding recurrence of accidental defects. It may be necessary to conduct a random-assignment factorial experiment (RAFE) test over a period to pin down the causes of rejection.

At each vital point, quality-control cards containing the important check points are provided for each group of cores, castings, sand mix, etc., equally essential to maintain proper identities for each job which may consist of the use of follow-up cards with details noted at each stage of inspection.

Conclusion

Casting defects provide an insight into the current practice and suggest the kind of supervision necessary to develop an improved technique that eliminates the human element. In a mechanized foundry, it is essential to use specialized equipment—templates, automatic signalling clocks, etc.—and to exercise care in laying down the handling procedure. The analysis of casting defects may include chemical analysis, physical tests, microscope examination, sound analysis, and consultation of process-control data and other relevant data. Only after ascertaining the precise reasons for their occurrence can moulding practice, core-setting procedures, gating, feeding system, etc., be changed. Whatever changes are made, should be effected one at a time maintaining full records at each stage, followed by inspection reports at subsequent stages.

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Bulgarian Foundry Technology

The April issue of the Bulgarian journal, Machinostroenie, contains an article entitled "Is it Expedient to Introduce Induction Furnaces without Steel Cores?" This article examines the metallurgical possibilities of such furnaces, induction furnaces without steel cores and for melting ordinary and high-grade cast irons, pointing to their advantages and limitations. The article is primarily aimed at finding complementary solutions for the existing situation and the superheating of cast iron in a cupola and in an induction furnace. The possibilities of applying induction furnaces is simple and practical. Benefits of such new techniques are also considered. Technical advantages of induction furnaces are listed and a survey made of the experience of introducing such units into the metallurgical practice of machine-tool works in Bulgaria.

PAISLEY TECHNICAL COLLEGE changed its name to Paisley College of Technology on June 1, when its new £1,000,000 extension came into use. The new buildings and equipment will mean that the National Certificate courses can now lead on to more advanced classes in technical education and the College will also be able to offer facilities for research work. The College was recently selected as a centre for technical industrial liaison in co-operation with the Department of Scientific & Industrial Research.