FOUNDRY NOMENCLATURE

THE MOULDER'S POCKET DICTIONARY

AND

NOTES ON FOUNDRY PRACTICE, APPLIANCES, MATERIALS, ETC., ETC.

BUCHANAN.

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The Moulder's Pocket Dictionary

CONTAINING

OVER TWO THOUSAND WORDS, TERMS AND PHRASES, OF SPECIAL IMPORT AND APPLICATION IN THE FOUNDRY

AND

NOTES ON FOUNDRY PRACTICE, APPLIANCES, MATERIALS, METALS, TEST-BARS, CAST-IRON SCRAP, SHOP RECEIPTS, USEFUL MEMORANDA, RULES AND TABLES

A Concise Guide to the Facts, Phrases and Terms Relating to Foundry Practice and Foundryology

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PREFACE

MANY of the words and phrases in everyday use in foundries are not clearly defined or understood; many more are used in a loose sort of way; while the meanings attached to others have only a local significance. A Moulder in a Stove Foundry or a Pipe Foundry uses a different set of trade terms from one in a Jobbing or Marine Foundry, and the Brass or Steel Moulder very often speaks a different dialect from the Iron Moulder.

While examining papers by Students in a class on "Ironfounding" at a technical school, the Author was also impressed with the gross misuse of technical terms. The technicalities of processes are oftentimes expressed in words or phrases which obscure the meaning to those unacquainted therewith.

From these reasons Foundry Nomenclature is necessarily expansive and—many of the terms being vague, fanciful and somewhat elusive—liable to misinterpretation.

This Pocket Dictionary is an attempt to gather up the terms in general use which are of practical interest to Foundrymen (regardless of their bearing on Philology, Etymology, Literature or Science), and present the *trade definitions* and technical applications of words and phrases familiar to Moulders.

It is hoped the supplementary matter may prove a useful addition to the work.

J. F. B.

CONTENTS

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THE MOULDER'S POCKET DICTIONARY.

INTRODUCTION.

LANGUAGE is the common medium of expressing ideas. Words are the clothing we put upon our thoughts, and may be graceful, pointed, poetical or uncouth, according as the vicissitudes of custom or necessity, or the varieties of vocation, may demand. We are continually coining new words, and allowing old ones to fall into abeyance or become obsolete; thus it frequently happens, even in ordinary conversation, that words or phrases are used the sense or precise meaning of which may not be at once evident. Synonyms are unscientific, and therefore confusing when employed to designate trade operations or appliances. To be perfect, the tradesman wants to call a spade a spade all the time; unfortunately this fact has been overlooked to a large extent in the foundry, and thus a host of words require explanation, or translation, so that the meaning may be generally comprehended.

Numerous reasons could be assigned for trade terms being circumscribed, ambiguous, and apparently inept or inconclusive; but probably a better illustration of their laxity could not be given than the accepted explanation of the familiar phrase *a cock and bull story*, viz. "numerous mistakes were made in interpreting hieroglyphic writings in the middle of the seventeenth century; the figures being so uncouth, and the renderings so unsatisfactory, that to two of the most common illustrations it was alleged of some translators that they had mistaken a cock for a bull."

Tradesmen have their peccadilloes like other people, and trade etiquette is probably as inexorable in its precedents and practices as even the most hidebound society forms. To know the "correct thing," or correct word, is surely as essential in the workshop as it is in the drawing-room. Besides, tradesmen acquire the trade manner and speech, like their mother tongue, as part of their training, and fall into mannerisms and colloquialisms automatically, and oftentimes quite unwittingly.

The less scientific tradesman is apt to use homely expressions to convey his ideas, or to make known his wants, and indeed, he may be none the less thorough a tradesman for so doing. Moulding is an art which is encased in truly scientific operations which for the most part have not been formulated, or have only received scant acknowledgment by the foundry operative. The average moulder is heedless of the bearing science may have on his work. So long as he can successfully accomplish the objects of his calling on the lines of recognised foundry practice by use and wont, or by "rule-of-thumb," he is content. It must, however, be admitted by men of progressive ideas that the spirit of inquiry is more healthful than the spirit of content, just as the *foot rule* is more accurate than that of the *thumb*. The ideal moulder is a born leader, confident and resourceful; a past master in the principles of mechanics, a student of physics and chemical laws, besides being an artist instinct with feeling for symmetry, and with a fine sense of touch—in brief, he is impossible as an individual. But on the other hand, the average moulder is an automaton—an imitator and no more; he lacks initiative and leans on his fellows. One man picks up a certain tool and gives it a name—he adopts it; another characterises a particular operation—he accepts it; a third individual, may be a stranger to foundry work, comments in foreign terms on a familiar foundry incidence—he assimilates the stranger's view of things. With this system, or rather haphazard method, of accumulating data or directions we have no fault to find; it has a broadening effect, but it is obvious that difficulties must arise as to the meaning, origin, or particular application of terms and phrases of such irregular inception. For example, the word *soldiers*, as applied to pieces of wood placed at regular intervals to support a hanging part of a mould, might justly be termed a misnomer, seeing they are not likely to "stand fire." An old pensioner making his debut in a foundry might be excused if an order to *cut out a lot of soldiers, line-up the hand shanks,* and *get ready for the charge,* non-plussed him; but a moulder knows that a "soldier" in the foundry is different from one in the field, and the "charge" is the amount of metal he is likely to get through at a time. Again, the familiar foundry phrase, *sun about,* would bewilder almost any tradesman, but the moulder, who however little he may know about astronomy, instinctively closes his box with the sun's motion—or is it the earth's? Only a moulder, too, could be expected to understand the peculiar use of the word *Up!* when a casting is poured as a term of intense excitement, comparable only to the football enthusiast's use of the word "Goal!" when the ball has passed between the uprights. Further, the phrase *iron to iron* might convey much the same meaning as like to like, or back to back, to the lay mind, but how differently the moulder feels about the matter when he knows that all the valuable parts of a mould are bound "iron to iron," i.e. immovably. These are only a few examples of the force and scope of foundry nomenclature, and, we believe, reason enough for this compilation.

It is important that foundrymen, at least, should have an identity of ideas regarding the words employed to describe identical operations, happenings and tools, as an exact definition of terms is essential to clearness of thought. To this end, provincialisms require to be co-ordinated, and trade terms specifically described. For convenience in distinguishing between the various words which belong by established usage to the foundry, either as trade or technical terms, or as adaptations from ordinary expressions capable of specific description, we have had those words with a special trade meaning printed in bold type (thus—**AIR-FURNACE**), and for the sake of brevity we have used the symbols only of the various metals in stated compositions.

DICTIONARY.

Abbreviations:

Am. = American; Fr. = French; Lat. = Latin; Sc. = Scotch.
a., *n.*, *v.* = adjective, noun, verb.
Comp. = composition. Ex. = Example.
Words with a special trade meaning are printed in small capitals, thus: AIR-FURNACE.

A.

Abrasives. Hard substances, such as emery, carborundum, "stars," etc., used for rubbing the sand off castings.

Acid Steel. Steel prepared by the acid process in the Bessemer converter.

Actinium. A supposed metal, said by Phipson to be contained in zinc; so called because certain of its compounds are darkened by exposure to light.

Admixture. The compound formed by mixing substances together; or (*ad* + *miscere*, Lat.) that which is mixed with anything.

Aëration. Exposing to the free action of air, as in Bessemer's steel process; impregnating with air.

Æruginous. Of the nature of verdigris, or copper rust.

Affinity. The attraction which causes bodies to unite and form chemical compounds.

Afterblow. The blowing of air in a Bessemer converter after the carbon has been burnt out, in order to oxidise the phosphorus.

AFTERGLOW. The anomalous expansion, termed *recalescence,* which takes place when steel is cooled down from a white heat. As the temperature falls through dull redness (about 1200° F.), there is a sudden development of heat before the further fall in temperature takes place.

Aich Metal. An alloy capable of being hammered, rolled, or drawn. Comp.: Cu 60, Zn 38·2, Fe 1·8. Also called "Gedge's alloy."

AIR. The gases which generate in a mould when it is being cast; the moulder's object in venting is to dispose of these freely.

AIR-BELT. An annular ring in which the air from the blast pipes is diffused, so as to be delivered through the tuyeres in a continuous stream.

Aired; *Air-dried.* In a crumbling condition; when a green sand mould is air-dried, the edges and weak parts are apt to crumble away, or the sand may run before the inflowing metal and cause a dirty casting.

AIR-FURNACE. A reverberatory furnace; a crucible air-furnace.

AIR-HOLE. A fault in a casting, produced by a bubble of air; a blow-hole; a vent.

Albata. A name for German silver.

Alchemists. A school of chemists whose practice consisted in the pretended transmuting of the baser metals into gold and silver.

Alchemy. An art which aimed at transmuting the baser metals into gold, and led the way to modern chemistry.

Alfenide. An alloy of nickel and silver, electro-plated with silver.

ALGIERS METAL. (Fr. *métal d'Alger.*) White table-bell metal. Comp.: Cu 5 parts, Sn 94·5, Sb 0·5. Takes a beautiful polish.

Alignment. A formation in a straight line.

Alkahest. The fabled "universal solvent" of the alchemists.

ALL-MINE PIG. Pig-iron which has been smelted entirely from ore.

Allotropic. Changeable physical forms in certain of the elements.

Allotropy. The existence of the same element in more than one usual condition.

Alloy. A mixture of two or more metals formed by fusion.

Aluminium. A silver-white metal, extremely light and malleable; its elasticity and hardness are equal to silver. Never occurs native.

Aluminium-Brass. An alloy containing: Al 1 to 12 per cent., Cu 56 to 75 per cent., Zn 23 to 43 per cent., with tensile strengths ranging from 14 to 43 tons per sq. in.

Aluminium-Bronze. An alloy of 90 to 98 Cu, and 2 to 10 Al. Standard: Cu 90, Al 10.

Aluminium-Silver. An imitation silver; comp.: Cu 57, Zn 20, Ni 20, Al 3. Also an alloy of silver and aluminium; comp.: Ag 5, Al 95.

Aluminium-Solder. Comp.: Zn 57, Cd 43; or Zn 30, Sn 65, Bi 5.

Amalgam. Any union of mercury with another metal.

Amalgamate. To blend or unite metals to form compounds.

Amorphous. Without regular form, with reference to crystallisation.

Analysis. The resolution of any complex substance into its *primary* or *ultimate* constituents.

ANCHOR. A chaplet or stay.

Anchoring. A method of fixing isolated portions of a mould or cores by means of bolts, tie-wires, bars, grids, or wedges.

ANDIRON. Originally a fireplace built of stone and iron, distinguished from the ancient fireplace of stone and lime. This term is now used by stove-makers to designate the rests or "dogs" for fire-irons.

Angle. The inclination of two lines meeting at a point.

Annealing. Tempering by heat; the process by which cast steel and certain other metals are freed from crystallisation or brittleness.

ANTI-ACID METAL. An alloy which withstands the corrosive actions of acids; usually a mixture of copper and lead, and sometimes antimony. A good example: Cu 63 per cent., Pb 30 per cent., Sb 7 per cent.; used for chemical plant fittings.

ANTI-FRICTION METAL. A comparatively soft metal with smooth surface; used for lining up bearings or journals. Tin, zinc or lead (about 80 per cent. of either) combined with small proportions of copper and antimony, form the composition of the great bulk of this class of metal.

Antimony. A bluish-white, brittle, crystalline metal, which expands on solidifying and imparts this property to its alloys; a bad conductor of heat and electricity. *Tartar emetic* was discovered by Basil Valentine, a sixteenth century alchemist, who accidentally administered it in poisonous doses to his brother monks. This caused the mineral to receive the name "anti-moine" or anti-monk.

Aqua-fortis (Lat. = strong water). Nitric acid (dilute), used for "pickling" castings.

Aqua-regia (Lat. = royal water). A mixture of 1 part nitric and 3 parts hydrochloric acids, capable of dissolving gold or platinum.

ARBOR. A small spindle; a core-bar conforming to the shape of the core to be made thereon.

ARBOR DIANÆ (the Silver Tree). A silver amalgam, which is precipitated in a crystalline form by adding mercury to a solution of silver nitrate.

Arc. A segment of a circle.

Arch. "A curved member made up of separate wedge-shaped solids with the joints between them disposed in the direction of the radii of the curve." — *Webster.*

Area. The superficial contents of any figure.

Areometry. The art of measuring the specific gravity of fluids.

ARGENTAN. German silver; an alloy of copper, zinc and nickel.

Argentiferous. Producing or containing silver.

ARGUZOID. A common quality German silver for casting. Comp.: Cu 56, Zn 24, Ni 14, Pb 3, Sn 4.

Argillaceous. (Lat. *argilla* = white clay.) Of the nature of clay.

ARRIS. The sharp edge of a core or mould which has been made with square joints.

Arm. A projection or support.

Arsenic. A steel-grey, brittle, crystalline metal; tarnishes readily. At a low red heat it volatilises *without fusion.* Alloyed with lead for shot. A good conductor of heat and electricity.

Ashes. The residue of fuel after combustion; useful for venting cores, etc.

ASH METAL. A poor quality of metal, made from the skimmings and ashes of the brass-foundry.

Assay. To examine ores or compounds for the purpose of determining the particular proportions of metals contained in them.

Assay Ton. A weight of $29 \cdot 166\frac{2}{3}$ grms. The *assay ton* may be any convenient weight, but its subdivisions must bear to it the same relations as pounds and ounces bear to the actual ton.

Assaying. The chemical operation by which the quantity of metal in an ore or mixture is ascertained. It differs from analysis only in degree, and is performed in the *dry way*, as by heat; in the *moist way*, as by reagents; or by both methods.

Atomic Weight. The weight of the atom of an element as compared with the weight of the atom of hydrogen taken as a standard.

ÆRUGO NOBILIS (Lat. = noble rust). The characteristic green coating known as "patina," which is so highly valued on account of bringing out the beauty of the contours in bronzes.

Autogenous Soldering. A process of uniting the two edges of metals by fusion, without interposing another metallic alloy as a bond of union. Lead, aluminium, and even the refractory metals and alloys can be joined in this way by the aid of the oxyhydrogen blowpipe.

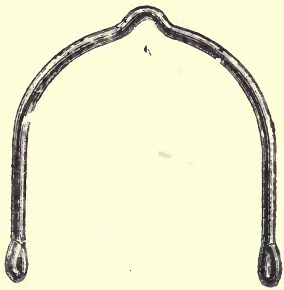
B.

Babbitt Metal. Any anti-attrition metal. Babbitt's original formula: Sn 88·9, Sb 7·4, Cu 3·7. Any alloy in this class which contains over 80 per cent. tin is called *genuine Babbitt* metal.

Babbitting. The lining of bearings with anti-friction metal, so called after the inventor of the process, Isaac Babbitt, Massachusetts.

Back Plates. Plates which are sometimes bolted to the back of moulding boxes which have to be cast vertically. They prevent the pressure of the liquid metal from forcing the sand outwards and avoid "swells," or "bursts."

Backing-out. A method of producing a pattern or casting from a half-pattern, or a block with only the external outline carved into it. An impression is taken from this and "thicknessed," and this forms the back or under side of the casting.



Bail.

Bag. To swell or hang down; used in the same sense as sag.

Baikie (Sc.). A box for holding loam. See Tote Box.

Bail. An arched handle for supporting the ladle by the shanks and connecting to the crane; sometimes called *the Bull*, and *the Bow*.

Bake. To harden by heat, as cores in a core-oven.

BALLING. Heating metal in a furnace and forming into balls for rolling. The last process is puddling.

BALLING. In refining metal drosses, the formation of oxide or infusible material surrounding the metal and hindering it from melting into one mass.

Baluster. A small column or pilaster for railing off stairs, etc.

Banca Tin. Straits tin.

Bank. A sandy slope, or a sloping mound.

BANK-UP. To heap up sand as a support; to enclose with sand.

Bare. Small as to size, i.e. barely the size.

Barium. A silver-white metal, difficult of extraction, of high specific gravity; melts at a very high temperature. The oxide is called *baryta*; the sulphate is known as *heavy spar*.

BARS. Bands of wood or metal which stretch across moulding boxes to prevent the sand from falling out.

Base (Fr. *bas* = low). The bottom or foundation; the bedplate of a loam mould.

BASE METAL. All metals losing their metallic lustre at ordinary temperatures or by heating are termed *base metals*; also a trade term for lead.

BASIC PIG. Metal made by the Basic process, by which the elimination of phosphorus and sulphur is rendered possible. A basic lining is used in the converter (dolomite), instead of ganister or other silicious material, as practised by Bessemer in the acid process.

BASIN. That part of the head which supplies the runners with metal while a mould is being cast.

BASIS METAL. The metal essential to, and forming the base of, a characteristic alloy, as P in phosphor-bronze, or Ni in German silver.

BATH. Many alloys are made by preparing a *bath* of the more stable metals, and immersing the volatile elements; a pickling vat.

Bath Metal. A very malleable brass alloy. Comp.: Cu 11, Zn 2.

Batten. A piece of timber which serves as a brace.

Bead Metal. A metal nearly the colour of copper, used for casting beads and bands for copper pipes. Comp.: Cu 80 to 90, Sn 3 to 6, Pb 6 to 14.

BEAM HOOK. A hook with a loop for sliding along the beam to any required notch. See *Lifting Beam.*

BEARING. In close contact; touching; the joint; resting place for a core.

BEARING METAL. The metal put into bearings, as locomotive bearings, hard gun-metal, marine engine bearings, Babbitt metal, etc.

BEAUMONTAGUE. The trade name for a cement composed of rosin, sulphur and iron filings; or borax, tin, beeswax and filings; used for filling up holes or flaws in iron castings. See *Filling*.

Bed. A layer of sand on which a core or mould may be turned over; an open-sand moulding bed.

Bed Charge. The quantity of coke and iron first charged into the cupola. The old rule of charging is to place three pounds of iron to one of coke in the bed, upon the bed, and ten to one upon the charges following. The bed is the amount of fuel required to fill the space in the cupola from the sand bottom to a given height above the tuyeres, locating the melting zone.

Bedding-in. Setting work in the moulding floor. See Phrases.

Bedplate. The bottom plate on which a loam mould is usually built.

Beeswaxing. Coating metal patterns with a film of beeswax to facilitate their withdrawal from the sand, and to keep the patterns from rusting.

Bell-metal. Hard bronze. Comp.: Cu 80, Sn 20.

Belt. A girdle around the cupola, carrying a series of tuyere pipes.

Bellows. *See* Notes on Appliances, p. 146.

Bench Work. Small work.

Berlin Iron. A very fusible variety of cast iron, from which figures and other delicate articles are manufactured; these are often stained or lacquered in imitation of bronze. The adjective Berlin is used here, as in other manufactures, to indicate a fine quality. Exs.: Berlin black; Berlin wool.

Besmear. To daub over; to blackwash castings for the purpose of hiding chisel marks or minor defects.

BESSEMER PIG. Pig iron of special quality prepared for conversion into mild steel by the Bessemer process.

BESSEMER STEEL. Steel made directly from cast iron by burning out a portion of the carbon and other impurities through the agency of a blast of air which is forced through the molten metal. So called from Sir Henry Bessemer, the inventor.

Bevel. Any angle other than a right angle.

BIBCOCK. A nose-cock.

BIDDERY-WARE. Indian art metal-ware. The material is a composition of zinc, copper and lead, in which ornaments of gold or silver are inlaid or damascened. Comp.: Zn 93, Cu 3·5, Pb 3·5.

BILLET. A short dumpy bar of metal, convenient for rolling or forging.

Bin. An enclosed place used as a receptacle for any commodity.

Bind. To restrain; to fetter, confine, or make fast.

BINDER. A bar of iron with bent ends, called toes, for gripping the top and bottom parts of a mould and keeping them together while it is being cast.

Bing (Sc.). A heap or pile.

Bisect. To divide into two equal parts.

Bismuth. A reddish-white crystalline metal; volatilises at a white heat; a bad conductor of heat and electricity. Bismuth expands on cooling, and is the most diamagnetic substance known.

BITE. A check; a pin inserted between geared wheels in a crane to keep it locked in one position.

BITUMINOUS FACING. See *Coal Facing.*

Black is often used to qualify metallic compounds or oxides, as black manganese, MnO_2; black antimony, Sb_2S_3; black copper = an earthy black oxide of copper; black tin = tin ore (cassiterite) in the form of a black powder ready for smelting; black silver = stephanite, a silver ore; black jack = zinc blende; blacklead = graphite.

BLACKBAND. A well known iron ore.

BLACK SAND. Old sand; used for mixing with coal dust and new sand for facing.

BLACKWASH. Liquid facing for moulds, of various compositions, as lampblack and clay-water or plumbago and molasses, etc.

BLAST. A forcible stream of air; the continuous blowing to which a charge of metal is subjected in the furnace. The terms *hot blast* and *cold blast* are employed to designate whether the current is heated or not before entering the furnace.

BLAST-FURNACE. Usually a shaft furnace for smelting ores.

BLAST GATE. A shutter for regulating the supply of air delivered by a blower, and to guard against explosions, which often occur from the accumulation of gas in the blast pipes during a temporary stopping of the machine. By using the gate, the blast can be regulated without regard to the speed of the blower; economy of fuel and correct pressure of blast are also ensured.

Blast Gauge. An instrument for indicating the air pressure in blast pipes. The pressure should be sufficient to force its way through the whole contents of the cupola when charged; it varies from 3 to 16 ounces per square inch, according to the size of the cupola.

Blaze. To heat slowly to a dark red.

Bleeding. Liquating; metal oozing from a casting through insufficient pressure, or being exposed before it is set.

Blending. Mixing different grades of iron.

Blister. A formation on the surface of a casting, caused by a *hard* or *wet* spot in the mould or gases in the iron; a film.

Blister Steel. Crude steel formed from wrought iron by cementation.

Block Moulding. A method of obtaining delicate castings by making plaster casts of top and bottom sides of the pattern, and moulding from these with interchangeable flasks. See *Plate Moulding*.

Block Print. A core print made larger than is actually required, to obviate difficulties in moulding, as drawbacks, deep lifts, chaplets, etc. The core is termed a block core. See *Pocket Print.*

BLOCK TIN. Ingot tin; slabs of tin, usually weighing 28 lb.

Blocks. That part of the lifting tackle by means of which the direction of motion is changed.

BLOOMING. The process of making *forge blooms* from the ore or scrap iron.

BLOW. The operation by which the iron in a converter becomes steel. The period in which a furnace is in blast.

Blower. A machine for creating forced draught.

BLOW-DOWN. To finish blowing a heat of metal.

BLOWHOLE. An air-hole in a casting.

Blown-in. Blast furnaces are said to be "blown-in" when they are in full working order. The first heats tapped are of an inferior grade, owing to the silicious lining attacking the metal as it melts. *Glazed Pig* is the name given to the metal produced during the period of "blowing-in." It takes about three weeks to "blow-in" a blast furnace, after which it is said to be in "full blast."

BLOW-OUT. A brassfoundry practice to break the castings off the gate while hot, and dip them at a certain temperature into cold water. This, if caught at the right moment, has the effect of blowing out the core, and leaving the casting without a particle of sand adhering to it.

BLUE-LINES. Those lines upon a drawing, usually in blue, which indicate to what parts the dimensions given have reference.

BOAT. A clay cone fixed on the end of a long rod; used for "boating-up," i.e. stopping the flow of iron from the cupola. (Colloquial.)

Bob. A polishing mop.

BODY CORE. The main core, as distinguished from branch or connecting cores.

BOILING. The ebullition of molten metal, caused by the presence of steam or gases; the condition of metal tapped into an imperfectly dried ladle.

BOLT. To sift or separate the coarser from the finer particles.

BOLT METAL. Any tough metal, as Muntz metal or Admiralty tough gun-metal. Comp.: Cu 14, Sn 1, Zn 1.

BOND. Any substance which serves to bind or hold together, as talc or molasses in plumbago, or clay in sand.

BONE-DRY. Perfectly dry; free from moisture. (Colloquial.)

Borax. A double salt of boron and sodium; used as a flux in soldering metals.

Bore. The size of a hole; the interior diameter of a pipe or cylinder.

Borings. Metal turnings.

BOSHES. The lower part of a blast-furnace which slopes inwards; in smelting and forging, a trough in which ingots and tools are cooled.

Boss (Am.). A master or foreman. Dutch *baas* = master. A knob or stud; also a thickness on a loam core, taking the place of a pattern.

Bot; Bot-stick. A long rod with a flat button forged on one end, upon which a cone of wet clay is pressed. This tool is used for plugging the tap-hole with clay after sufficient or all the iron has been allowed to run from the cupola.

Bottom-part. The drag of a moulding box, or the under half of a mould.

Bows. The name given to the tackle used for moulding propeller-blades in loam; curved plates with holes for fixing bars and binders into.

Box. A moulding box; the smaller sizes are termed flasks.

Box-cleaner, *n*. A tool for sleeking flanges, or moulds with square corners.

Box-Metal. *Axle*-box metal, usually composed of Cu 88, Sn 12.

Bracket. A support; often used to strengthen angles in castings.

Branch-Core. A separate core, or a connecting core.

Branch-Pipe. A pipe having branches, or connecting to the main body.

Brand. The manufacturer's mark on metal.

Brass. An alloy of copper and zinc. Comp.: Cu 2, Zn 1. Great variations are permissible in making brass, copper ranging from 60 per cent. to 94 per cent., according to requirements.

Brasses. Bushes; bearings; so called because frequently made of brass.

Brass-Fever. An ague caused by inhaling the fumes of brass.

Brass-Furnace. Usually refers to air crucible furnaces.

Brazier. A coppersmith.

Brazing. The process of hard soldering, i.e. soldering with an alloy of copper and zinc = brazing solder. Comp.: Cu 50, Zn 50.

Brazing Metal. An alloy suitable for brazing to copper; must stand a good fire test. Comp.: Cu 80, Zn 20 to Cu 90, Zn 10.

Bray. To pound or grind into fine dust.

Break, *v.* To sever as by fracture. *n.* The fracture of a metal.

Breaking. The action by which molten iron or phosphor-bronze assumes varying curves. By the different aspects of striation it is possible to distinguish between hard and soft iron while in the liquid condition.

Breast. The space in front of the cupola which is made up for the tapping hole. Sometimes called the Breast-hole.

Breeze. Small coal; charcoal dust.

Bricking-up. The building up of a loam mould with courses of brick.

Bridge. The division between the fireplace and the hearth in an air furnace; a form of scaffolding in a cupola.

Bristol Brass. Cu 61 to 75 per cent., Zn 39 to 25 per cent.; sometimes called Prince's Metal.

Britannia Metal. The alloy known under this name consists principally of tin alloyed with antimony, and occasionally copper and zinc. Exs.: Sn 90, Sb 6, Cu 3, Zn 1; standard, Sn 90, Sb 10.

British gum. Starch, reduced to a gum-like state by great heat.

BRONZE. An alloy of copper and tin, to which small proportions of other metals, especially zinc, are sometimes added. Standard, Cu 90, Sn 10; Admiralty bearing bronze, Cu 86, Sn 14.

Bronze Powder. A metallic powder, used with size, to give the appearance of bronze, gold or other metal to any surface.

Bronzing. The art of communicating to articles in metal, wood, plaster, etc., the appearance of bronze by means of bronze powders, or by chemical processes.

Brush. A tool composed of bristles for cleaning or polishing purposes, as *pattern brush*: a small, hard, pointed brush for cleaning patterns; *scratch brush*: a polishing brush for metal surfaces; *soft brush*: a camel-hair brush, used for dry facing; *dry brush*: a hand brush, with which the moulder sweeps away the sand from the joints of moulds and patterns.

BUCKLE, *n.* and *v.* A distortion, bulge or bend in a metal plate. Unequal internal stresses, due to different densities or rates of cooling, will cause buckles in castings.

Buff, *n.* A wheel covered with buff leather, used in polishing.

Buffer. An operative who grinds castings at a buff- or emery wheel; a fender to protect from shock.

BUGS. "The name given in some places to the small shot-scrap made in the vicinity of the cupola and along the track of the ladles, during the time of casting."—*Bolland.*

BUILDING. The containing walls of a loam mould.

BUILDING-RINGS. Cast-iron rings, used to support or strengthen a loam mould.

Bulge. To swell, as a mould when it yields to pressure.

BULL. See *Bail*: bull-ladle.

BULL-HANDLES. Handles bent like the horns of a bull, and suitable for being hooked up by the crane hooks; also called bow-handles.

BULL'S METAL. A high tension bronze, containing aluminium and manganese.

BULLION. Properly, uncoined gold or silver in bulk; in many brass-foundries bar lead is called *bullion*.

BUNGED, *v.* Stopped up; as a bunged cupola, where the iron is hindered from falling into the melting zone. See *Scaffold.*

BURDEN. The charge of metal, fuel and flux placed on the *bed* in the cupola.

Burn. To fuse and unite two surfaces of metal by pouring over them a quantity of the same metal in a liquid state.

Burnt Iron. Cast iron which has long been subjected to the action of heat; iron which is worthless owing to the absorption of oxygen. If burnt iron is included in the cupola mixture it must be used sparingly, as it renders the metal sluggish and produces an extraordinary amount of slag.

Burr. The turned up edge which commonly results from punching, drilling or cutting operations on metals.

Burst. A sudden rent, as when a mould runs out.

Bush. A ring of metal inserted in a machine part intended to receive wear; a ring used as a head for increasing the pressure on a casting.

Bush-Brass. A cheap brass, principally used for marine engine fittings. Comp.: Cu 46, Sn 5, Pb 3, brass 46.

Bush-Metal. A hard brass, commonly put into bushes. Cu 16, Sn 2, Zn 1.

Butt-Core. A core which presses against another core, forming a close joint.

Button. A technical term applied to the round mass of metal found at the bottom of the crucible after fusion, or in the cupel in the process of assaying.

Button Metal. Buttons are made of alloys which give sharp impressions and are easily pressed. White button metal, comp.: Cu 46·5, Zn 53·5. Brass buttons are mostly made from Bristol brass or similar alloys.

C

Cab. The driver's seat or carriage on a travelling crane driven from overhead.

CABBAGE POT (Am.). A kind of mortar, used for reducing scrap brass or other metal to a ball for charging into the crucible.

CAKE. A slab of dried sand, used for overlapping or covering a space or vacancy caused by taking away a loose piece from a pattern, such as a flange in a three-way pipe, or the snugs of a moulding box pattern.

Calamine. The common ore of zinc: *lapis calaminaris.*

Calcination. The heating of ores in order to expel some of the injurious contents, preparatory to their reduction to the metallic condition.

Calcium. A widely disseminated element; the carbonate, limestone, is a valuable flux.

Calin. This term is applied to an alloy used by the Chinese for lining tea-chests. Comp.: Pb 126 parts, Sn 17·5 parts, Cu 1·25 parts.

Camber. An upward curve on a beam or plate.

CAMLACHIE-CRAMP (Sc.). A patch cast round a broken piece of tackle, such as a box-part or a core-iron, to bind it together temporarily.

Cant. To tip over, or to set at an angle.

CAN-HOOKS. Broad faced hooks for gripping a flat surface; hooks which cannot swivel.

CAN-HOOK.

CAPE AND CORNER = diagonally. (Am.) Catty-cornered.

Capital. The head of a column.

Car (Am.). A truck or carriage moving on rails.

Carbon. An element which exists in three conditions: amorphous, graphite and crystalline. According to the condition and proportions of this element in iron, we get cast iron, steel or malleable iron.

Carborundum = carbide of silicon; an artificial mineral produced in the electric furnace; the most powerful abrasive known. Comp.: C 32 per cent., Si 68 per cent.

CARD (Am.). A set of patterns fixed on a board or plate.

CARDED PATTERNS (Am.). Patterns fixed on a board or plate for plate or machine moulding.

Card-Wire. A piece of carding cloth, used for rubbing cores, etc.

CAR-LADLE. A ladle on wheels, convenient for distributing molten metal. See NOTES ON APPLIANCES.

Carriage. The foundry bogie or truck for conveying moulds in and out of the drying stove.

CARRYING BAR. A stout iron bar having a depression in the middle, by means of which two or more men can support a heavy weight, or carry the single end of a shank ladle.

Case-hardening. A process for hardening the surface of iron castings. The article to be case-hardened is rubbed over with prussiate of potash, or put in an iron box with shreds of leather, horn, etc., heated to a blood-red heat, and then immersed in cold water.

CAST, *n.* An impression taken from a pattern. *v.* To pour metal into a mould.

CASTER. In many of the foundries divisional labour prevails, and the business is carried on in three distinct branches, viz. core making, moulding and casting. The caster only closes moulds and casts them.

Casting. Any article which has been cast; the process of pouring molten metal into a mould.

CASTING-ON. The process of uniting cast to wrought iron work by pouring the former around the latter while placed in due position.

CAST IRON. The product of the blast-furnace; a mixture of iron and certain proportions of the metalloids carbon, silicon, phosphorus, sulphur, etc.

Cast Steel. Crucible cast steel is generally understood by this term, although there are other methods of casting.

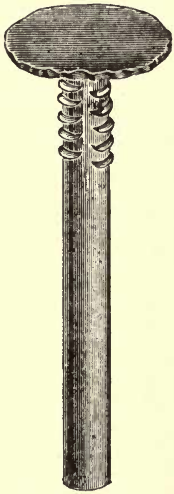
CEMENT. Any compound used for filling up holes in castings. See *Filling.*

Cementation. The process by which the chemical combination of substances absorbed by iron produces steel.

CENTRE-BLAST. A cupola or converter having the blast in the centre of the hearth.

Centesimal Proportions. One-hundredth parts.

Chamfer. The surface formed by cutting away the arris or angle made by two faces of a piece of wood, metal, sand, etc.



CHAPLET.

CHANGE HOOK. A triple hook, sometimes termed a *ram's horn* because of its shape; the third hook is central and turned at right angles to the double hooks above. It is a convenient tool for passing loads from one crane to another.

Change-Wheel. A toothed wheel which, when geared, effects a change in the power or motion of a piece of machinery: as the crane.

CHAPLET. A metal stud for holding a core in position in the mould.

CHAPLET-BLOCK. A block of wood or metal which is bedded below the mould, to support the stem of a chaplet. See PHRASES, p. 114.

CHARCOAL IRON. Iron made in a furnace in which wood charcoal is the fuel used. A strong iron, showing angular crystals; superior for many purposes to the anthracite or coke irons.

Charge, *n.* The quantity of metal, coke, etc., put into the furnace for one heat. *v.* To load or fill.

Charger. A funnel for charging metal into crucibles.

Charging-door. The opening through which the metal is charged into the furnace.

Charging Floor. The platform from which the cupola is charged.

Charging Tongs. Tongs for charging metal into crucibles.

Charred. Burned; reduced to cinder.

Chauffer (Fr. *v.* = to heat). A small stove, usually a cylindrical box of sheet iron, with a grate at the bottom and an open top. See also *Firelamps; Kettles.*

Cheek. A section of a flask so made that it can be moved laterally to permit the removal of the pattern from the mould; the forepart or place of anything.

Chemical Analysis. The separation of a compound substance by chemical processes into its constituents with a view to ascertain either what elements it contains, or how much of each element is present.

Chemical Mix (Am.). A mixture of cast iron calculated from the chemical analyses of the different grades composing the charge.

CHILL, *n.* A metal mould. *v.* To produce a change of crystallisation at or near the surface of cast iron, so as to increase the hardness. Some kinds of cast iron *chill* to a greater depth than others.

CHILLED IRON. Iron which has been hardened on the surface by chilling. Some mixtures of cast iron are more susceptible to chill than others.

Chimes. A set of bells musically tuned to each other.

Chink. A small opening or cleft.

CHINSE, *n.* A piece of waste used as a swab. *v.* To close up cracks in a mould which has been dried by moistening the surface, and dressing with *chinsing sticks.*

CHIPPER (Am.). A dresser = a hammer and chisel man; a pneumatic chisel.

CHIPPING-PIECE. An extra facing of metal, allowed on some castings for fitting.

Chock. A wedge or block, used to fill in any space and act as a rest.

CHOKE. To block up or obstruct, as in *choking a riser.*

CHURNING. Feeding.

CINDER-BED. A cinder-bed is the safest means by which vents are provided with a sure outlet in moulds and cores having large surfaces.

CIRCUS. A revolving table for conveying boxes from a stationary moulding machine to the casting floor.

CLAMP, *n.* A tool for holding the parts of a box together. *v.* To bind anything.

CLAUT (Sc.). A long-handled rake for gathering the slag off the metal in a reverberatory furnace. See *Rabble.*

CLAYS. Pieces of clay which have been used for testing the thickness or metal space in a mould.

Claywash. Clay and water mixed; used for sticking cores together, or for washing over the bars and sides of boxes or lifters.

CLEANER. A tool for cleaning loose sand from a mould. (Am.) A dresser, who cleans castings.

CLEANING (Am.). Dressing castings; cleaning room = dressing shop.

CLEAN-LIFT. When a pattern is withdrawn from a mould, or a top part is lifted without any of the sand being torn away, that is called a clean-lift.

CLEAN METAL. Metal free from kish, scoriæ, dross, or oxide.

CLEARANCE. The space allowed so that one part of a mould or core will *clear* another while being fitted; the part shaved off the joints or prints of a mould to allow for fitting.

CLICHÉ CASTING (Fr.). A mode of obtaining an impression from a coin, die or woodcut, by striking it suddenly upon metal which has been fused and is just becoming solid. *Cliché Metal* comp.: Pb 50, Sn 36, Cd 22½.

Clinch. To hold fast; to make secure.

CLINKER. Black oxide of iron. It is always formed when iron is heated to redness in the air.

CLIP. To cut the radius or angle on a branch- or butt-core.

Clog. To adhere, as sand to a pattern. (Sc. Clag.)

CLOSE; CLOSING. The act of finally shutting up a mould prior to casting it.

Clouded. Shaded, tarnished or irregular in colour or appearance, as badly applied lacquer on polished brass, or varnish on wooden patterns.

COAT. A layer or course, as *first coat*, *rough coat* and *finishing coat*, or *fine coat* on a loam core.

Cobalt. A metal occurring in meteoric iron, and in conjunction with nickel; first discovered pure by Brandt in 1733. Taking silver as 100, its electrical conductivity is only 17·22.

COCK METAL. An alloy of copper, zinc and lead, used for small water-taps; the zinc is generally added in the form of yellow brass. Ex.: Copper 20 parts, yellow brass 15 parts, lead 2½ parts.

Cold-Chisel. A chisel tempered for cutting cold metal.

COLD-SHORT. Brittle when cold.

COLD-SHUT. Closed or set while too cold to become united; a flaw in a casting, due to cold metal at that part. Also called Cold-shot.

COKE. The solid residuum produced by the destructive distillation of coal.

COKE-FORK. Coke is better handled with a fork than with a shovel; only clean coke of the proper size can be charged with it.

COLLAPSIBLE CORE-BARREL. A form of core-bar adopted in pipe foundries to facilitate the removal of the core from the casting and save the cost of hayband, the loam being daubed directly on to the bar. An ordinary collapsible bar consists of three longitudinal segments held in circular section by internal cones wedging them outwards. After the casting is cooled the cones are knocked back and the segments collapse.

Combined Carbon. Carbon which has entered into chemical combination with iron. According to the proportion of combined carbon in iron we get *white iron*, *chilled iron*, *steel*, etc.

Combining Weight. "That proportional weight, usually referred to hydrogen as a standard, by which an element unites with another to form a compound." The combining weights are either identical with, or are multiples or submultiples of, the atomic weight.

Combustion. The chemical union of bodies with oxygen.

Composition. The ingredients required to complete an alloy; for example: in making brass, the copper is first melted, and then the composition or zinc is added in.

Composition Metal. Muntz metal, or any alloy used instead of copper for sheathing vessels.

Compressed Steel. Cast steel which has been subjected to pressure while in a molten condition. The object of compression is the production of a sounder ingot than can be obtained in an open mould.

COMPRESSED CASTINGS. Castings made under compression. By an ingenious arrangement a vacuum is set up within the mould simultaneously with the action of a piston forcing the metal into the mould.

Contraction. Shrinkage; the property by which bodies assume smaller dimensions.

CONVERTER. A retort used in the manufacture of steel, in which molten cast iron is decarbonised by a blast of air passing through the liquid metal; a trunnion ladle with blower attachment.

COOLER. A bad casting. In brass-foundries doing light work, bad castings are sometimes used for cooling the metal to the proper casting temperature.

Coom. Soot; smoke black.

COPE. The top part of a flask or mould; the outer part of a loam mould.

COPE-RING. The cast-iron ring upon which the cope of a loam mould is built.

Copper. A common metal of a deep red colour, very malleable and ductile, and one of the best conductors of heat and electricity. It is one of the most useful metals in itself and in its alloys.

CORE. The portion of a mould which shapes the interior of a cylinder or other hollow casting; a part of the mould made separate from, and inserted in it, for shaping some part of the casting, the form of which is not determined by that of the pattern.

CORE-BARREL. A tube with perforations for the escape of gases, used for spinning cylindrical cores in loam.

CORE-BOX. A box conforming to the shape of the internal parts of a casting, usually in halves or divisions, for convenience in ramming or turning out cores.

CORE. Many of the words to which CORE is prefixed are self-explanatory, as core-bench, core-bay, core-gum, core-iron, core-maker, core-oven, core-sand, core-arbor, core-wash, etc.

CORING-UP. The placing of cores in their position in a mould in readiness for casting.

CORE-STOCKS. Core-boxes.

Corinthian Brass. Brass is fabled to have been first accidentally formed at the burning of Corinth, 146 B.C.

Corrosion. The dissolution or eating away of metals by corrosive agents, acids, alkalies, etc., due to chemical action.

COURSE. The quantity of sand which it is convenient to ram properly in a mould at a time; the course varies with the size of the work. A layer of bricks.

COVER-CORE. A core which fills a gap left in a mould by withdrawing a part of the pattern without making a special joint or parting.

Crack. A partial separation of parts; a common flaw in castings.

CRAMP. A device, usually of iron bent at the ends, used to hold the parts of a mould together in turning over, or while casting.

CRIB-PLATES. Plates for confining a large mould, especially a loam mould. These plates are bound together, and the space between them and the mould is rammed securely with sand.

CRONK. Crooked; twisted; wrong.

CROSS. A seating with arms for supporting the spindle with which loam moulds are swept up; also a four-armed beam used for lifting heavy moulds.

CROSSHEAD. The beam which carries a loam-board when it is meant to work up and down instead of revolving with the spindle.

Crow-Bar. A chisel-pointed bar used for pinching the carriage into the stove, or for applying a large leverage for a temporary purpose.

CROWDIE (Sc.). Meal and water, a drink used by workers at furnaces.

CROWN. The dome of a reverberatory furnace.

CRUCIBLE. A melting-pot, composed of plumbago, fireclay, and other very refractory substances.

CRUCIBLE FURNACE. A pit furnace.

CRUCIBLE STEEL. The invention of Benjamin Huntsman, over 160 years ago. Crucible cast steel is still recognised to be the most uniform in quality, and the hardest and most reliable steel for cutting tools. See notes on STEEL.

Crush. To bruise or squeeze, so as to destroy the natural shape of a piece; to compress by pressure or weight.

Crystallisation. The process by which a substance in solidifying, or by mechanical conditions, assumes the form of a crystal, or becomes crystallised; crystallisation implies brittleness.

Cupel. A small, flat, cup-like crucible, made of bone-ash, used in assaying the precious metals.

Cupellation. The process of purifying gold and silver by melting them with lead, which becomes first oxidated, then vitrified, and sinks into the cupel, carrying all the baser metals with it, and leaving the gold and silver on the surface.

CUPOLA.

CUP-HEAD. A cup or basin which is scooped out at the top of a runner; a head flush with the top of the flask in which a mould has been made.

CUPOLA. The iron-founder's furnace for melting and mixing pig-irons and producing irons suitable for various kinds of castings. A space furnace in which iron is melted in direct contact with the fuel, and is supported by the fuel previous to melting.

Cupola Blocks. Circle fire-bricks for lining cupolas.

Curb-Plate. See Crib-Plates.

Cut, *v.* To scar or sever; to *scab*; to slice sand with a shovel for the purpose of mixing it. *n.* A scab made by the cutting action of molten metal on a sand mould.

Cutting-Piece. A stick for cutting off part of a mould not desired to be cast, and to save cutting the pattern.

Cut-off. A deadhead or sullage piece; an addition to the length of a casting made perpendicularly, to collect impurities and give extra pressure to the required parts.

D.

Dabbers. Prods, cast on core-irons, building rings, etc., to make the sand or loam adhere.

Dam, *n.* A reservoir or tank used for gathering metal in large quantity, to cast heavy castings. When sufficient metal has been collected the dam is emptied by raising a shutter controlled by a lever. A firebrick wall which forms the front of the hearth of a blast-furnace. *v.* To obstruct the flow of metal.

Damascus Iron. Metal formed of iron and steel wires elaborately twisted and welded together; flexible iron.

Damascus Metal. A locomotive-bearing metal, containing lead.

Damascening. A process of decorating metals by inlaying, incrusting with another metal, or by etching with acids.

DAUBING. Coating roughly with damp sand or loam.

DEADHEAD. A sullage piece, sometimes called a "head"; the part or extension piece on a casting poured in a vertical position, which contains the greater portion of the oxides and impurities; a part of a casting which is not paid for.

DEAD METAL. Sluggish metal, liable to produce *cold-shuts.*

DELIVER. A term applied to the withdrawal of the pattern from the sand. It is said to deliver well or ill according to the state of the mould and the manner in which it parts from the sand.

Deflection. The deviation from a right line, especially of a test bar under a load.

DELTA METAL. An alloy of great strength, composed of copper, zinc and iron, with occasionally additions of phosphorus or manganese.

Delve. To dig with a spade.

Density. The quality of being compact; the specific gravity of substances referred to water at a temperature of 4° C. as a standard.

Deoxidised Bronze. An American steam metal with a small addition of phosphorus. Comp.: Cu 82; Sn 12, Zn 4, Pb 2, P 0·05.

Deoxidiser. Any reducing agent, or any substance that neutralises the oxides in molten metal.

Derrick Crane. A crane having facility for hoisting and also for swinging the load horizontally.

DETAILS. Small parts or connections.

Diamagnetic Metals. Metals which are repelled on being brought near to a magnet, as Bismuth.

Diameter. A straight line passing through the centre of a circle, and terminating at both ends in the circumference.

DIAMOND-POINT. A faceted chisel.

DIP, *n.* Inclination downwards. *v.* To immerse in a liquid, as brass castings in aquafortis or *pickle.*

DIPPING METAL. Fine yellow brass. Comp.: Cu 73, Zn 27.

DIPPER. An operative who dips castings, or works in the dipping shop.

DIRT. Sullage; dross; specks of sand or cinder in metal.

DISH. To depress in the middle, or to make concave like a dish.

DISMANTLING. Taking adrift; separating the parts of a mould to get out the casting.

Dodge. A makeshift; a tricky device.

DOG-RAMMER. See *Flat-Rammer.*

DOGS. Holdfasts, used for keeping parts of a pattern or core-box together; rests for fire-irons.

Dolly. A polishing bob.

Dose. To saturate an alloy with some adulterant, as lead in brass.

Double Contraction. The allowance made for contraction when a casting is meant to be used as a pattern.

Dowel. A pin fitting into holes in two abutting pieces, as the halves of a pattern or core-box, to keep them in proper relative position.

Dowel.

Draft. The taper allowed on a pattern for drawing it out of the sand. See *Deliver*.

Drag. The bottom part of a flask or mould.

Drawback. A method of getting away an undercut part of a pattern by drawing back that portion of the mould and resetting it; also the plate or frame which supports the portion drawn back.

Drawhook. See *Drawspike*.

Drawn. Shrunk; a hollow place in a casting.

Draw Damp. To absorb damp from the surroundings, as a dry-sand core in a green-sand mould.

Draw-down. A drop or sinking of the surface of a mould, especially where there are thick sections of metal or square corners; due to insufficient *soldiering*, or excessive moisture in the mould.

DRAWING STRAPS. Iron straps fastened to a pattern for drawing it out of the sand.

DRAWSPIKE. A sharp-pointed tool for drawing small patterns. Also called a Drawhook.

DRESSING. Fettling castings; cleaning; finishing a mould.

DROP-OUT. An unexpected collapse of the cope or hanging part of a mould.

Drop-Test. See NOTES ON TEST BARS, p. 211.

DROSS. Scum; the waste matter which forms on the surface of molten metals.

DRUM. A cylinder of large diameter; a core-barrel made from wrought iron.

DRUNK. The condition of being crooked, or "out of truth." See *Sided.*

Drying Stove. A brick chamber with a fireplace, for drying cores or moulds.

DRYSAND, *n.* Rock sand; the sand used for drysand moulding.

Ductility. That property of metals by which they may be drawn or extended without breaking.

Dull. Sluggish; inert. Dull metal is used by preference for heavy castings.

DUMB FLOW. A riser which does not come through the top part.

DUMB SCAB. A patch of sand which has peeled from the mould and adheres to the surface of the casting, creating a hollow, which is usually covered with a crust of metal.

DUMB-VENT. A vent from a hollow core led to some distance by means of an underground flue, where there will be no possibility of sparks igniting the gas and causing an explosion.—*Bolland.*

DUMMY-BLOCK. A model for the underside of a jacket or other core. When the core is dried the block is removed, leaving the core in the position in which it was swept up.

Dump, v. (Am.). To unload, as by tilting a cart or hand-barrow. ***n.*** The foundry rubbish-heap.

DUST BAG. A bag (sometimes a stocking-foot) which is used for holding flour, plumbago or soapstone, to dust moulds with.

DUTCH GOLD. One of the most malleable alloys; also called dutch-leaf, dutch-foil, dutch-metal, and bronze-leaf. Comp.: Cu 11, Zn 2.

E.

EKE (Sc.). An addition; a portable extension-piece for a box.

Elasticity. The power of bodies to recover or rebound after the removal of external pressure or force; springiness.

Elastic Limit. The limit of distortion that a body can undergo and yet return to its original form when relieved from stress; also the unit force or stress required to produce the distortion.

ELBOW. A bend-pipe ; an angle.

Electric Furnace. A furnace giving highly elevated temperatures, whose potential heat is supplied by the electric arc.

Electrolysis. The process whereby chemical compounds are separated into their constituents by means of electric currents. The electro-chemical equivalent of a metal is the weight in grammes deposited by 1 *coulomb* of electricity.

Electro-Metallurgy. The art of precipitating a metal by electro-chemical action. Metals deposited by this method are generally freer from impurities than those which are refined in the ordinary way.

Electrotype. A cast produced by electro-deposition.

Electrotyping. Copying by precipitating copper or other metal in solution through the agency of electricity.

Elongation. The state of being lengthened out ; extension.

Emery. Grain corundum, used for grinding and polishing hard substances ; generally in the form of emery cloth, emery powder, or emery wheels.

EMPTYINGS (Am.). The lees of beer, used for hardening cores ; also surplus metal which is poured out.

Engraving-Bronze. An alloy suitable for sign plates and panels. Comp. : Cu 100, Sn 15.

ENTERED ! An exclamation used by moulders when closing the parts of a mould together, indicating that their end of the box has entered the guide-pins or stakes.

Expanding Metal. A metal which expands on solidifying. Comp.: Pb 9, Sb 2, Bi 1.

Expansion. The act or power of spreading out or enlarging, especially the property of metals to expand by heat.

Explosion. A chemical action which causes the sudden formation of a great amount of expanded gas, as the explosion caused by the generation of gases in a mould, or the mixture of molten metal and moisture (hydrogen gas).

Extruded Metal. Metal pressed into various sections, as by Dick's patent process; metal which has been stamped or pressed into shape.

Eye-Bar. A pointed or chisel bar with an eye forged on one end.

F.

FACING. A powdered substance, as charcoal, coal-dust, plumbago, etc., applied to the face of a mould, or mixed with the sand that forms it, to give a fine smooth surface to the casting.

FACE-BOARD. See *Face-Plate.*

FACE-MOULDING. A process of moulding for obtaining a sharp impression. The mould is dusted over with some facing, as lampblack or plumbago, and reimposed upon the pattern. (Am.) *Return-moulding.*

FACE-PLATE. A smooth plate, or board, on which patterns forming a plain parting in the mould are placed in position for ramming up the drag. See *Follow-Board.*

FAINT. Lacking in detail; cold-shut; not sharp or full.

Fake, v. To gloss over defects. The substance used for filling up defects in a casting—Beaumontague: Scotch cement.

FALSE-CORE. A loose piece of a mould; a drawback. Sometimes the undercuts in a pattern are filled up temporarily, and after it is withdrawn from the sand, false-cores are carefully rammed in their several places.

FALSE PART. A parting which cannot be moved without destroying the mould.

Fan. A wheel with vanes fixed on a rotating shaft, inclosed in a chamber, to create a blast of air.

FAN.

FATIGUE. The weakening of a metal when subjected to repeated strains.

Faucet. The enlarged end of a section of pipe which receives the spigot-end of the next section.

FEEDER. A rod used for pumping metal into a casting while it is solidifying; an excess of metal above a mould which serves to render the casting more compact by its pressure.

FEED-RING. An extension on a casting for feeding.

FENTON'S METAL. An anti-friction metal. Comp.: Zn 79, Sn 16, Cu 5.

Ferro. A prefix indicating *ferrous iron* as an ingredient. Exs.: ferro-aluminium, ferro-manganese, ferro-sodium, etc.

Fettle. To put in order; to clean or prepare, as, to fettle castings, to fettle a furnace, etc.

FETTLERS. Dressers; casting-cleaners.

FILLER (Am.). Cement for filling up defects in castings.

Fillet. A rounded corner where two surfaces meet.

FILLING (Am.). The substance used to fill a cavity. See *Fake.*

FILLING-IN. See FOUNDRY PHRASES, p. 114.

FILLING-UP PIECE. A shaped piece which is inserted in a mould to fill up any part not required in the casting.

FIN. A ridge left on a casting at the junction of the parts of the mould. The surplus metal formed on a casting by the metal filling the clearance, or fitting-space, allowed in all moulds, for joints or cores.

Fining. To purify metals.

FINISHING. After the pattern has been withdrawn from the sand, all the work done in preparing the mould for casting is embraced in the term finishing; mending and slicking.

Finishing Coat. The final coat of loam or facing applied to a mould or core.

Fireclay. An infusible clay, free from iron, lime, or any alkali—used for lining furnaces, etc.

Fire-Gilding. A mode of gilding with an amalgam of gold, the mercury being driven off afterwards by heat.

Firing. The mode of introducing fuel into the furnace and working it.

Fire-Lamp. A local term for a chauffer which has been cast. See Kettle.

Fire-Sand. Silicious sand intermixed with more or less alumina. Sand for foundry purposes requires to stand a high "fire" test, hence *fire-sand.*

Fireworks. Sparks from molten iron. (Colloquial.)

Fit-on. To try on, or adjust the parts of a mould.

Flaked. Streaked; scaly; marked; as a flaked or imperfect casting produced by the assembling of minute particles of sand or facing, which have run before the liquid metal.

Flare Plate. See *Glimmer.*

Flare-up. A sudden burst, or spilling of metal on the floor.

Flask (Am.). The box or frame which holds the sand forming a mould. When there are more than two parts in a complete flask, it is called a three-part flask, or a flask with cheeks, or mid-parts, as the case may be.

Flat Top. The top part of a mould which has been *rammed up* or *swept up* without being imposed upon a pattern; a plain top.

Flat-Rammer. The rammer which is used near the top of a mould, or on the bed of an *open sand* mould, to resist pressure.

Flaw. A defect or blemish.

Flooded. Filled to excess, as when a casting having perforations comes from the mould with the whole surface covered over with metal.

Floor Sand. Moulding sand which has been used in the floor.

Flour. Common flour, used in foundries for dusting on moulds, or mixing with core-sands.

Flow. A riser; *Flow-off*: a riser which is led into a gutter.

Flower. The radiated crystalline appearance on the surface of soft solder, by which experts judge of the quality.

Flue. An enclosed passage for directing a current of air.

Fluor-spar. Calcium fluoride: a powerful flux in cast iron, steel, etc. About 6 lb. to the ton of iron is sufficient when it is used simply as a flux.

Flux. Any substance or mixture used to promote the fusion of metals; a solid reagent, added for the purpose of forming a compound with the earthy matter in an ore or metal.

Foal's-foot. A rounded ripping chisel.

Follow-Board (Am.). A face-board which, being shaped to the outline of the top side of a pattern, obviates the making of a parting; literally a wooden oddside. See MATCH-BOARD.

FONDERIE À CALABASSE (the Calabasse process). An economical method of melting and using scrap-iron for small ornamental castings, practised by Belgian ironfounders.

FORMER. See *Strickle.*

Formula. Specified mixture. A method of expressing a rule by symbols.

Founding. The mechanical art which comprises all the operations of reducing ores, and of smelting and casting metals.

FOUNDRY IRON. Iron undergoes some changes other than being melted in the cupola; the phrase *foundry iron* generally refers to iron ready for turning into castings.

Foundry Ladle. A vessel for holding molten metal and conveying it from the cupola or furnace to the moulds.

Foundry Practice. The methods of doing work in a foundry.

Foundryology. The science of founding and its literature.

FOUNTAIN-RUNNER. See *Horn-gate.*

FRACTURE. The texture of a freshly broken surface. Metals are often bought or blended by the fracture only; the fracture of a metal varies with its purity, temperature, and the manner in which the rupture has been produced. Fractures are usually classified as: 1, *crystalline* (as antimony, bismuth, zinc); 2, *granular* (as cast iron); 3, *fibrous* (as wrought iron); 4, *silky* (as copper); 5, *conchoidal* (as crucible cast steel); 6, *columnar* (as tin or lead).

FRAME. An additional part to make a flask deeper, called in America a *flask-riser*; a mid-part.

FREE SAND. Sand which has little clayey matter in its composition; sharp sand.

Freezing Point. That degree of a thermometer at which a fluid begins to freeze; the *setting point* of metals: the degree of heat at which a metal begins to solidify or set.

FRENCH FLOW. A sarcastic term for a *run-out.* (Colloquial.)

FRENCH SAND. A natural moulding sand, of a fine strong texture and velvety surface; suitable for intricate bronze castings.

Frush. Easily broken; friable, as burnt sand.

Fuel. Combustible matter used for fires, furnaces, etc.: coal, coke, wood, oil, gas, etc.

FUEL RATIO. The quantity of fuel required to produce a given proportion of fluid metal suitable for making castings.

Fulcrum. That by which a lever is sustained, or about which it turns in lifting or moving a body.

FULL BLAST. The highest melting capacity of a cupola, or the greatest pressure of fan or blower.

Fumes. Vapours; smoke.

FUNNEL. A vent pipe; a filler; a vessel of the shape of an inverted hollow cone, terminating below in a pipe, and used for filling crucibles with scrap metal or borings.

Furnace. An inclosed place in which heat is produced by the combustion of fuel, as for reducing ores or metals. Furnaces are classified as *air furnaces* when the fire is urged only by natural draught; as *blast furnaces* when the fire is urged by the injection artificially of a forcible current of air; and as *reverberatory furnaces* when the flame, in passing to the chimney, is thrown down by a low arched roof upon the materials operated upon.

FURNACE LINING. The highly refractory materials used for lining furnaces, as fireclay, ganister, etc.

Fusible Metal. An alloy which melts at a low temperature. Comp.: Newton's, Bi 8, Pb 5, Sn 3; Onion's, Bi 5, Pb 3, Sn 2. The former melts at 202° Fahr.; the latter melts at 197° Fahr.

Fusibility. The quality of being fusible.

G.

GAB. The mouth or opening of a hook, as a crane hook.

Gable. The end of a building; a template giving the sweep of a propeller blade.

Gaffer. The foreman.

GAGGERS. Hangers: pieces of iron imbedded in the sand of a mould to keep it intact.

GAGGERING. The method of setting gaggers.

Gallium. A rare metal, resembling aluminium, and remarkable for its low melting point (86° Fahr.).

Galvanised Iron. Iron coated with zinc by being plunged into a bath of molten zinc.

Galvanising. Coating iron with a layer of zinc to keep it from rusting.

Galvanic Action. The mutual action of certain liquids and metals; dynamical electricity; the action which causes corrosion in metals.

Gang. A squad: a group of labourers under one foreman.

Gangue. A term applied to silicious matter, constituting the matrix of some ores.

GANISTER. A refractory silicious stone, which is ground and mixed with fireclay for lining furnaces, cupolas, etc.

Gas. An elastic fluid, commonly referred to in the foundry as *air*.

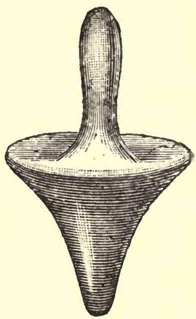
Gas Coke. The soft coke which results from the dry distillation of coal in gas-works. It is too friable for use in the cupola, although suitable for drying stoves and brass furnaces.

GATE. The channel or opening through which metal is poured into a mould; sometimes called the *ingate* or *git*: a sprue. There are numerous forms of gates, as *ball-gate*, a gate with a ball cut behind it for the purpose of feeding; *branch-gate,* a gate leading from the main gate; *horse-shoe-gate,* a double gate forming a horseshoe; *pop-gate* or *plump-gate,* a direct-pouring gate; *skim-gate,* a gate designed to skim the metal on its way into the mould; *spray-gate,* a series of gates for small castings, branching off a central runner, sometimes called a *finger-gate.*

GATE-CUTTER. A moulder's tool for scooping a channel for the metal to run in by; also a machine for cutting off gates from castings; *gate-knife.* See *Sprue-Cutter.*

GATE-PIN. An upright runner which forms the connection between the pouring head and the casting.

GATE-SPOOL. An inverted cone with a knob-like handle; it is used for shaping and smoothing the runner, or head, in small moulds.



GATE-SPOOL.

GAUGE. A template for gauging dimensions. See *Size-stick. Wind-Gauge,* an instrument for measuring the force of the blast.

Gear. Tackle; plant; the mechanism which transmits motion to the parts of a machine.

GERMAN SILVER. A silver-white alloy, hard and tough, containing copper, zinc and nickel in varying proportions, with sometimes small additions of iron, lead or tin. Standard comp.: Cu 60, Zn 20, Ni 20.

GIG. A stool with a central socket for a spindle to work in; the gig is used for sweeping up small loam jobs.

GLIMMER. A plate covering the ladle to keep the glare of molten metal from the workmen.

Glow. To shine with an intense or white heat; to be incandescent.

Goggles. A kind of spectacles for protecting the eyes of furnacemen, etc.

Gold. The most malleable metal. The Standard gold of Great Britain is an alloy containing 8·33 per cent. copper. Colour, yellow; when molten in large quantities, green.

Gold Solder. Comp.: Au 12 parts, Ag 2 parts, Cu 4 parts.

GOLDEN BRONZE. Aluminium-bronze.

Gong. A flat saucer-shaped bell.

GONG-METAL. Comp.: Cu 82, Sn 18.

Grab. A tool for gripping objects to enable them to be moved about.

Grade, n. Quality. *v.* To classify; to regulate the content and condition of carbon in pig-iron, as *grey*, *mottled* and *white*.

Grade No. The mark of quality in cast-iron. No. 1, a soft porous iron which has to be mixed with scrap or other grades with smaller crystals for finished work; the fracture presents a large crystal of dark bluish cast. No. 2, a medium close iron which takes a fine finish. No. 3, the common grey iron, used for general castings.

Grain. Texture; the arrangement of the particles of a metal.

GRAIN TIN. Refined tin of the purest quality.

GRAPHITE. Carbon—exists in cast iron in two states, graphitic and combined. *Free* carbon.

GRATING. A cast frame with crossbars; a core-iron.

GREEN. Imperfectly dried; damp; moist.

GREENSAND. Moulding sand used for a mould while slightly damp, and not dried before the cast is made.

GREY IRON. Cast iron containing a comparatively high proportion of graphitic carbon.

GRID. A grating; a core arbor.

GROUT, *v.* To fill in with grout, i.e. thin mortar, as the joints between bricks.

GRUNTER. A hook used in brassfoundries in lifting crucibles up to the pouring-hole of a flask intended to be cast vertically.

Gudgeon. The pin fastened in the end of a shaft or core-barrel.

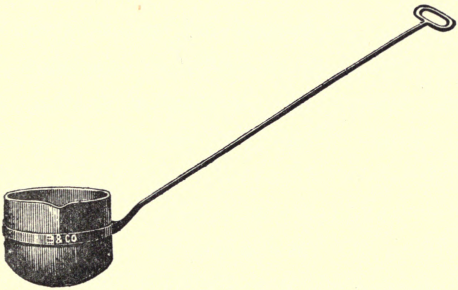
GUIDE MARKS. Clay or loam patches fixed on the sides of a moulding-box, or dents on the sections of a loam mould, and marked across the joint before the mould is separated, to enable it to be put together again with the parts in proper position;

a makeshift, used where box-parts are not provided with pins.

Gun-Metal. Usually an alloy of copper, tin and zinc. as Admiralty gun-metal. Comp.: Cu 88, Sn 10, Zn 2, or Cu 87, Sn 8, Zn 5.

Gutter. A channel for leading metal into a pig-bed, or for venting a core.

Guy. A guide rope; a rope or chain attached to anything to steady it.



Hand-Ladle.

H.

Hack-Saw. A light frame saw for cutting metals by hand.

Haft. A handle.

Hammered Metal. Metal hardened by hammering it when cold.

Hand-Ladle. A small ladle which can be carried comfortably by one man.

HANGERS. Gaggers: pieces of iron for carrying the weight of projecting or depending parts of a mould.

HARDENING. An alloy of equal parts copper and tin, used in the manufacture of anti-friction metals and bell metal; the element which has the effect of hardening a soft metal, as copper in gold, zinc in aluminium, antimony in lead.

HARD IRON. Iron which is machined with difficulty: *white iron.*

HARD LEAD. Lead which has been alloyed with some hard metal, as antimony in type-metal, tin in pattern-metal, and arsenic in shot-metal.

HARD SOLDER. Brazing solder; any solder which sets with a hard surface, and is difficult to melt.

Hardness. Comparative degrees of firmness or unyielding qualities in metals.

HATCHING. Lines on a pattern or drawing bringing out details.

HAY-BAND. Hay-rope, used for making loam cores: the rope is wound on the core-barrel to make up the difference in size between the barrel and the core diameters; to bind the loam securely to the barrel; and to assist in venting the core.

HEAD. The top of a runner which is enlarged to supply the mould with metal; a *cut-off* or *sullage-piece.* Also the height of a column of liquid, or the pressure equivalent to that height.

HEARTH. The floor of a furnace on which the material to be heated is placed; the bed of a furnace on which the metals melt.

HEAT. The quantity of metal melted at a single operation.

HEAVY METALS. The metallic elements not included in the groups of alkalies, or alkaline earths, specifically: gold, mercury, platinum, lead, silver, etc.

HEMATITE. An important ore of iron; also a special kind of pig-iron, used for strengthening other brands.

Hemp. Hemp or tow is used for winding on small core-bars previous to daubing on the loam; it is also wrapped round gate-pins to prevent the sand from getting into mould while the head is being rammed.

HERCULES METAL. An aluminium-bronze, containing iron; made by the Cowles Co.

Hitch. A knot or noose in a rope which can be readily undone.

HOLLOW-WARE. Cast-iron kitchen utensils, pots, pans, kettles, boilers, etc.

Hook. A piece of metal formed into a curve for catching hold, as an *S-hook*, a double link, shaped like an S; *link-hook*, a hook with an eye for linking on to an open hook.

HOOP-BINDER. A length of hoop-iron encircling a course of bricks in a loam mould and having tension applied by tying the ends with wire and twisting till perfectly taut.

Hopper. A chute, usually funnel-shaped, for feeding material to a machine; *bell and hopper,* the apparatus at the top of a blast furnace through which the charge is introduced while the gases are retained.

Horn-Gate. A tapered circular gate, which supplies the metal from underneath the mould, filling it with the least possible amount of friction.

Horse-droppings. A common ingredient in loam and core and facing sands, rendering them porous and suitable for conveying gases from the mould.

Hot-Blast. Heated air; until the year 1828 iron ores were smelted by the aid of a current of air drawn direct from the atmosphere, then the hot-blast, which is effected by the utilisation of waste furnace gases, was introduced with a view to economising fuel. Cold-blast iron is stronger than hot-blast.

Hot-short. Brittle when hot.

Hydraulic Gun-Metal. A metal capable of withstanding great hydraulic pressure. Ex.: Cu 87, Sn 13.

I.

Imitation, a. Often used adjectively to characterise things which have a deceptive appearance, as *imitation bronze,* cast-iron coated with bronze-powder; *imitation gold,* some of the brass alloys.

IMPURITIES. Foreign matter; undesirable elements in a metal.

Incandescent. White, glowing with intense heat.

Infusible. Incapable or difficult of fusion.

INGATE. The principal channel by which the metal is run into the mould.

INGOT. A bar of metal which has been cast in a mould; also the mould itself, *ingot mould.* Ingot copper, steel, etc. Iron and lead in this form are called *pigs*; tin, *blocks*; zinc, *cakes*; gold, *bars.*

INSIDE STAKES. A term applied in sarcasm to the marks left by unequal ramming close on the joint of a mould. See Monkey Knuckles.

IRISH TIN. A nickname for *Pig Lead.*

Iron. Probably the most abundant, useful and valuable of all the metals. Iron is employed for mechanical purposes in three states, viz. cast iron, wrought iron and steel. Cast iron is now treated as an alloy of pure iron with the metalloids carbon, silicon, phosphorus, sulphur and manganese, and the various grades are produced by controlling the proportions of these elements present.

J.

JACKET-CORE. A core forming an outer covering, or surrounding the main core in a casting.

JAM. To wedge, squeeze into a tight position, or press close.

JAMMER. A spring chaplet. See *Springer.*

JEWELLERY. Delicate castings, especially fine brass-work.

Jib. The projecting arm or beam of a crane.

JIG. A contrivance fastened to or enclosing a piece of work; a templet or guide.

JOINT. The place where two parts, as of a mould, are capable of being separated and put together; a parting.

Journal. That part of a machine which turns in a bearing, as a shaft, spindle, etc.

JUMPER. A long chisel-bar or a quick-cutting tool, used for "jumping" a hole.

"JUMPERS." The sparks which scintillate from fused iron containing a high proportion of carbon in the "combined" condition.

K.

Kaolin. China clay, extensively used for making clay crucibles for steel melting.

KARA KANE. Japanese bell-metal. Comp.: Cu 10, Zn 1·5, Sn 4, Ag 1·5.

"KEEP'S TEST." A method of determining the percentage of silicon in cast iron, invented by W. J. Keep, Detroit. A test-bar is cast against an iron yoke, and the silicon content is judged by the amount of shrinkage and chill.

KETTLE. A chauffer or small fire-lamp, used for drying loam moulds at certain stages of construction.

KILL. To counteract: as for example, antimony is said to *kill* the lead in a cock-metal mixture.

KILLED-SPIRITS. Soldering fluid: spirits of salts (muriatic acid) which has been neutralised by the action of zinc.

KINGSTON'S METAL. An almost obsolete anti-friction metal. Comp.: Sn 88, Cu 6, Hg 6.

Kink. A twist in a rope or chain.

KISH. Grit or scum in metals.

Kit. A trade outfit: a kit of tools.

KNURLED. Provided with ridges: milled, as the edge of a coin.

Kunzel's Bronze. Comp.: Cu 66 to 91, Pb 4 to 15, Sn 4 to 15, P 0·5 to 3.

Kupfernickel. False copper. The arsenide of nickel. The word "Nickel" is a term of detraction, having been applied by the old German miners to what was looked upon as a kind of false copper.

L.

LA CIRE PERDU (Fr. = the lost wax). Briefly, this consists of modelling a pattern in wax, surrounding it with plaster of Paris, firing it to burn out the wax, then casting the metal into the cavity.

LACQUER. A varnish, consisting of a solution of shellac in alcohol, and some colouring matter like saffron, dragon's blood, etc.; applied to metals to keep them from tarnishing.

Ladle. An iron pot or vessel to carry molten metal from the furnace to the mould. See NOTES ON APPLIANCES, p. 151.

LAMB AND FLAG. A famous brand of tin—Cornwall tin.

LAMINATED. Scaly; thin layers with little adhesion.

LANTERN. A temporary drying apparatus. See *Fire-lamp.*

LE MOULAGE FRANÇAIS. The French system of moulding statuary and intricate ornamental castings. The pattern is reproduced in sections by the ordinary dry-sand methods, and the pieces are afterwards joined by means of mortise and tenon joints, screws, or *burns.*

Lead. A bluish-white soft metal, of low tenacity, largely used in the manufacture of pipes, sheeting, etc.; also an important ingredient in many of the alloys, as type-metal, solder, cock-metal, anti-friction metal, etc.

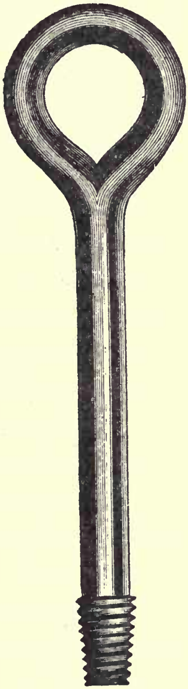
LEAN. Thin; bare as to size; smaller than the print or size-stick.

LEAVE. Separate; part.

Level. An instrument used for finding the horizontal line.

LIFTER. A rod with an eyelet, which is fixed into core-irons, or an iron bent to hang from the bars or sides of a cope; a tied *gagger*; (Am.) a *cleaner* or tool for lifting loose sand from the mould. See *Cleaner*.

LIFTING-SCREW. A kind of eye-bolt which screws into a plate fixed in the pattern, and enables the moulder to get a steady lift in drawing the pattern.



LIFTING-SCREW.

LIGHT ALLOYS. Alloys in which aluminium is the chief component.

LIGHT METALS. Alkali metals or metals of the alkaline earths.

Limestone. Calcium carbonate; a valuable flux for cast iron.

Lining. The internal covering of anything, as furnace lining or ladle lining.

LINING METAL. Babbitt metal, or anti-friction metal used for lining bearings.

Lip. The mouth or pour of a ladle.

LIQUATION. The separation of an easily fusible metal from one less fusible, as tin from copper in bronze.

LOAD. To adulterate or to saturate, as lead or zinc in some alloys, or mercury in some amalgams.

Loadstone. Magnetic iron ore.

LOAM. A mixture of sand, clay and other materials, used in making moulds for large castings, often without a pattern.

LOAM-BOARD. A strickle, sweep, or templet, for shaping some part of a mould in loam.

LOAM BRICK. A mass of loam which has been shaped in a brick-mould and then dried. Loam bricks are chiefly used for building where the ordinary bricks, on account of their rigidity, would interfere with the free contraction of the casting.

LOAM-CAKE. A flat slab of dried loam. See *Cake*; *Cover-core.*

LOAM MOULDER'S CROSS. See *Cross.*

LOAM MOULDER'S HORSE. A top bearing for the spindle which is kept in position by a tie-rod. See NOTES ON APPLIANCES, p. 157.

LOAM MOULDER'S GIG. A stool with a central socket, upon which loam moulds may be built and lifted off again.

LOAM MOULDER'S SQUARE. A graduated square with a notch to allow it to fit close against the spindle; used for marking angles, circles, etc.

LOAM-PLATE. The foundation plate of a loam mould.

Locker. A cupboard for tools having a lock attached.

LOOSENING-BAR. A rapping-bar, usually round and pointed, for jarring patterns previous to lifting off the cope or drawing out a pattern.

Long Ton. 2240 lbs. The ton in U.S. is sometimes reckoned as 2000 lbs.

Loose Piece. A part of a pattern which is not fastened in any way, and is withdrawn after the main pattern has been taken out.

Loss. Waste: the proportion of metal which oxidises or volatilises during the process of melting.

Lost. Spoiled: the moulder speaks of having "lost" a casting if it turns out bad.

Lottinoplastique. M. Lottin de Laval's method of taking paper moulds of inscriptions, basso-relievos, etc. An adaptation of this method has been found useful for rotary presses requiring flexible stereotypes curved to fit the moving drum.

Lug. That which projects like an ear, as the *lugs* of a moulding box, or loam-plate.

Lute. To close or seal up a joint; to lute on the cover of a crucible.

Luting. Fireclay or loam daubing used to lute anything.

Lycopodium. A vegetable powder, largely used in the manufacture of fireworks, and in America by moulders to prevent the sand from clogging to patterns.

M.

MACHINE MOULDING. See NOTES ON APPLIANCES, p. 146.

MAGNALIUM. An alloy of magnesium and aluminium. Comp.: Al 100, Mg 10 to 30.

Magnesium. A silver-white metal, malleable and ductile; used chiefly in pyrotechny and photography, and recently in alloys for mathematical instruments.

MAGNOLIA. A famous anti-friction metal, the principal ingredients of which are: lead, tin, antimony and bismuth.

MAILLECHORT. A German silver containing about 15 per cent. nickel and a small proportion of iron.

Makeshift. A temporary expedient.

MAKING-UP PIECE. A piece of wood for making-up any deficiency in a mould after the pattern is withdrawn.

Malleable. Capable of being extended or shaped by beating or pressing.

MALLEABLE BRONZE. Tobin bronze. Delta metal.

MALLEABLE CAST. Partially decarbonised cast iron; articles made from pig iron and made malleable by heating in the presence of oxides, which deprives the cast iron of some of its carbon.

Mallet. A small maul or mell with a short handle.

MANDRIL. A bar of metal inserted in the work to shape it; a metal core.

Manganese. An abundant metal which much resembles cast iron in appearance and physical properties. The metal oxidises too readily to be of much service, except as an ingredient of some few alloys, as *manganese-bronze*, where 2 per cent. manganese added to an ordinary brass alloy greatly increases the strength, hardness and ductility of the metal; or *ferro-manganese*, used for increasing the density and hardness of steel.

MANGANESE-PIG. Iron made from ore containing somewhat more Mn than the regular grades.

MANILLA METAL. An alloy of copper and arsenic, from which the money used by certain tribes of the West Coast of Africa is made; a volatile alloy. Akin to Muntz metal.

MAPPED (A.). Streaked; *mapped casting* is sometimes caused by too much sea coal used in the sand; the surplus facing is washed in irregular lines by the inflowing metal.

Marine Acid. Spirit of salt. Muriatic acid.

Marine Glue. Ordinary glue, made with an addition of milk or linseed oil, to assist it to repel moisture.

MARINE METAL. An alloy of lead, antimony and mercury, for sheathing ships.

MARKS. Characters or indications serving for guidance in fitting parts of a mould together. See *Guide.*

Master Pattern. A pattern from which duplicates are made, and having double shinkage allowed.

MATTE. The first product obtained from the smelting of copper or other ores. In the case of copper it consists principally of sub-sulphides and about 40 per cent. metallic copper; also a dull, frosted surface on metals.

MATCH (Am.). An oddside; a perforated board, block of plaster, hardened sand, etc., in which a pattern is partly imbedded, for giving shape to the surfaces of separation between the parts of a mould (plural *matches*).

MATCHBOARD. See MATCH.

MECHANICAL ANALYSIS. See *Keep's Test.*

MELTING POINT. The degree of heat at which a metal passes from the solid to the fluid condition.

MELTING RATIO. See *Fuel Ratio.*

MELTING ZONE. The space in which iron is melted in the cupola, usually from 12 to 20 inches above the top of the tuyeres.

MEMBER. A line; a notch in a loam-board, serving to locate certain radii in the mould.

Mend. To repair, restore or patch; to make good any fault.

Mercury. A metallic element which is liquid at ordinary temperatures, and solidifies at $-39°$ C. to a soft, malleable, ductile metal. Alloys of mercury with other metals are called amalgams.

Metal. The distinction between a metal and a non-metal is a purely artificial one. Chemists define a metal as an electropositive element capable of reflecting light and conducting heat and electricity, and whose oxides have basic rather than acid properties. Popularly the name is applied to certain fusible metals, as gold, silver, copper, etc., and also to the mixed metals or metallic alloys, as brass, bronze, steel, etc.

METALLOGRAPHY. The science of microscopic analysis of metals.

Metalloids. Elements which in the free state are unlike metals, and whose compounds possess acid rather than basic properties.

Metallurgy. The art of separating and refining metals from their ores.

MID-PART. A frame for a moulding box; the middle part in a three-part box.

MINARGENT. An alloy used by jewellers, consisting of Cu 100 parts, Ni 70, W 5, and Al 1.

MINERAL FACING. Anthracite coal, or low graphite carbon facing, which is meant merely to be dusted on a mould when a particularly smooth surface is not required.

MIRROR METAL. Speculum metal, usually an alloy of copper, tin and arsenic.

MITIS CASTINGS. Castings made from a mixture of wrought iron, cast iron and aluminium-bronze, the invention of a Swede named Ostberg.

Mixer. A machine for mixing sand; or the material used for giving special qualities to moulding-sand. In brassfoundries, the term is generally applied to the furnaceman.

MIXING METAL. An alloy prepared for the purpose of mixing in with other metal. See HARDENING.

MIXTURE. The ingredients composing an alloy. See *Composition.*

MOCK PLATINUM. A white alloy, used for buttons, etc.; white brass. Comp.: brass 8, zinc 5.

Modelling. The art of designing or copying works of art in clay or wax.

MODULUS OF ELASTICITY. "The measure of the elastic force of any substance expressed by the ratio of stress on a given unit of the substance to the accompanying distortion or strain."

MOIRE-MÉTALLIQUE (Fr.). The ornamental appearance obtained by treating the surface of metals, as tin, aluminium, etc., with dilute acids.

MOKUM. An alloy used for decorations upon gold and silver articles made by the Japanese. It is prepared by placing thin plates of gold, silver and copper upon each other, and stretching under the hammer.

Molasses. Treacle, used for mixing into core-sand.

MONKEY. A weight or ball which, being raised on high, falls on any object underneath; used for breaking heavy pieces of cast iron.

MONKEY KNUCKLES. Indentations on the parting of a mould, due to irregular ramming. The moulder who produces them is the laughing stock of his fellows. See *Inside Stake.*

MOTTLED IRON. Pig-iron which is between the two extremes of *white* and *grey*. The fracture shows a decided mottle, portions of white iron being scattered through a matrix of grey iron.

Mould. The cavity from which anything is shaped; matrix.

MOULDER. One skilled in the art of making moulds for castings.

MOULDER'S GLUE. Expectorations. (Colloquial.)

MOULDER'S TOOLS. The tools which the moulder carries about with him are small, but numerous. They include trowels, level, rule, slickers, cleaners, callipers, etc. Other tools of trade are supplied by the masters, and are called shop tools.

Moulding Sand. Sand suitable for making moulds, containing clay, and sometimes mixed with other materials, as sawdust, flour, coal-dust, etc., to make it open.

MOULDING STALL. A division for a moulder to work in; a bench.

MOULDING TUB. A trough in which small moulds are made in brassfoundries.

MUDDING-UP (Am.). See *Steam-up*.

Muffle. A furnace for annealing castings; a covering or compartment used in furnaces to protect objects heated from the direct action of the fire.

Muntz Metal. Comp.: Cu 60, Zn 40.

N.

Nail, n. A stud. *v.* To fasten or secure with nails.

Native Metal. Few of the metals are found pure in nature—gold is the most prominent; free or uncombined metal.

NAVAL BRASS. An alloy frequently specified by the British Admiralty. Comp.: Cu 62, Zn 37, Sn 1.

Nave. The hub of a wheel.

NEST. A set of small core-tubes of graduated size.

NEST-EGG. A mould left over from the present cast and meant to figure in the next heat. (Colloquial.)

NEW METAL. A metal or alloy melted for the first time, as distinguished from re-melted metal or metal made with scrap.

NEW SAND. Sand fresh from the quarries and pits, furnished to founders for moulding purposes.

Nick. To cut or mark, as a piece of metal, to see the fracture.

Nickel. A white tenacious metal, strongly magnetic; next to manganese, nickel is the hardest of all metals. The addition of Ni reduces the corrodibility of steel, and increases its tenacity.

Nippers. Small pincers or pliers for cutting wires.

NOBLE METALS. Metals which do not combine with oxygen when heated in contact with air, and at a red heat remain indifferent towards water. Silver, gold, mercury and platinum are the most important metals belonging to this group.

Notions (Am.). Small wares or trifles.

NOWEL (Am.). The core or inner part of a mould for casting a large hollow object; also the bottom part of a flask in distinction from the cope: the drag.

Nugget. A lump of metal.

NÜRNBERG GOLD. An alloy which is frequently used in the manufacture of cheap gold ware. Au 2·5, Al 7·5, Cu 90.

NUTS. Small coal: fuel which has been screened.

O.

⊙ on a pattern usually indicates a screw, nail or pin which requires to be undone in the process of moulding, so as to allow the pattern to be drawn.

ODDSIDE. A box part, usually rammed with sand, and having the impression of the top-part of the pattern; used for making the parting, or to save bedding in. See MATCH.

Offer. To bid, or estimate a price.

OPEN HEARTH. The shallow hearth of a reverberatory furnace.

OPEN-HEARTH STEEL. Siemens-Martin steel. Cast iron is converted into steel by the addition of wrought iron, or iron ore and manganese, and by exposure to heat in an open-hearth furnace.

Open-Sand Moulding. A method of moulding only applicable to castings having a flat upper surface; moulding without a cope or top-part.

Ore. Any native metallic compound. Ores are occasionally alloys, but the great majority of them are associated with other elements, as oxides, sulphides, carbonates, etc.

Ordnance Bronze. The original *gun-metal*, Cu 90, Sn 10.

Ormolu (Fr.). An alloy much used for purely artistic purposes. Comp.: Cu 58·3, Sn 16·7, Zn 25·3. Another example of this *gold-bronze*: Cu 90, Sn 6, Zn 4.

Oroide (Fr.). An alloy, chiefly of copper, zinc and tin, resembling gold in colour and brilliancy.

Ounce Metal (Am.). An alloy suitable for steam fittings. Comp: Cu 16, Sn 1, Zn 1, Pb 1.

Output. The weight or number of castings put out of the foundry in a given time.

Over-all. A shop term for an outermost dimension.

Oxide. "A binary compound of oxygen with an atom or radicle"; popularly referred to as rust.

Oxidation. Combining with oxygen.

P.

PACKFONG. Chinese white metal, resembling German silver. Comp.: Cu 40·4, Ni 31·6, Zn 25·4, Fe 2·6.

PACKING. Pieces of iron for making up space between binders.

PAINT. Liquid facing: blackwash, corewash, etc.

PALLIONS. Thin strips of metal, used for soldering fine work or jewellery.

PANCAKES. Surplus metal which has been poured out on the floor.

PAPER-PARTING. Paper makes an excellent substitute for parting-sand at parts of a joint where it is difficult to apply the sand either in the wet or dry condition; it is mostly used in loam-moulding as a separator between parts.

Parcel. A lot or portion of anything, as a parcel of gun-metal.

Part. To separate.

PARTING. The joint of a mould; the outline which separates the parts of a mould.

PARTING SAND. Burnt sand, used for covering a joint so as to keep the parts of a sand mould from adhering.

PASTED CORES. Cores which have been dried in halves and then pasted together with flour paste.

Patch. To mend, or make up deficiencies.

Patent Metal. Any *Babbitt* or anti-friction metal. Babbitt's metal was originally known as "Babbitt's Patent Metal"; when other makers of this class of metal entered the lists, the word Babbitt's was dropped naturally.

Patina. The æruginous coating which comes on bronzes by exposure to the atmosphere. See *Ærugo Nobilis.*

Pattern. A full-sized model, around which a sand mould is made to receive the metal. Patterns are mostly made of wood, but they may be made from any substance strong enough to resist the pressure of ramming, etc. There are many kinds of patterns: as *solid pattern,* a pattern cut out of the solid wood or metal; *built pattern,* a pattern made up of small pieces glued together; *skeleton pattern,* a pattern giving the outline of the casting only; *shell pattern,* a pattern which permits core and mould to be made simultaneously; *carded patterns,* a plate having patterns fastened on one or both sides.

Pattern-Metal. Patterns which would be liable to warp, or be easily damaged if made in wood, are made in metal. Cast iron is not the most suitable metal for patterns, although, owing to its cheapness, many are made therein. For small patterns and duplicates a soft metal with low shrinkage is a *desideratum.* Tin 8, and antimony 1, makes a fine pattern-metal, but for heavy patterns the expense would be an objection. Aluminium has lately come into favour as a metal suitable in many ways for foundry patterns. It compares favourably in price, weight, and general results with any of standard pattern alloys.

PEEL. To strip off the skin or burnt sand on the face of a casting.

PEEN. To stretch or draw metal with the peen of a hammer.

Peg. A wooden pin.

PEGGING RAMMER. A light narrow rammer, used for pressing the sand into corners.

PENDULUM. A slicker for deep flanges.

PENE; PENE RAMMER. See PEGGING RAMMER.

PERISHED METAL. Metal which has oxidised or lost its original strength. "Burnt" iron.

PEWTER. A hard, tough, easily fusible alloy, originally consisting of tin with a little lead, but modified later by the addition of antimony, copper or bismuth.

PHILOSOPHER'S WOOL. The flakes of zinc oxide which rise from the yellow-brass alloys are termed "Philosopher's Wool."

PHOSPHOR-BRONZE. An ordinary bronze containing from 1 to 3 per cent. P. The phosphorus is introduced into the bronze generally as phosphide of tin, and imparts increased hardness, elasticity, etc. to the metal.

Physical Properties of Metals, usually considered, are: specific gravity, hardness, fusibility, volatility, tenacity, elasticity, elongation, ductility, malleability, conductivity, fracture, flowing power or viscosity, and welding.

Pickle. A bath of dilute acid for removing burnt sand from castings, or to improve their colour.

Pickling. Dipping castings; treating with acids.

Pig. An oblong mass of metal, as pig-iron, pig-lead; ingot.

Pig-Bed. A sand bed arranged with a series of channels for running metal into ingots called *pigs.*

Pig-Iron. Cast iron as it comes from the smelting or blast-furnace.

Pig-Iron Breaker. A machine for breaking up pig-iron into short lengths for charging into the cupola.

Pin. A foundry term for a *gate-pin* or a *flask-pin.*

Pin-Board. A strickle board having a pivot.

Pinholes. Minute air-holes, which sometimes show on a casting after it has been machined.

Pinchbeck. An alloy of copper and zinc, invented by Christopher Pinchbeck about 1700; much used in the manufacture of cheap jewellery. Comp.: Cu 88, Zn 12.

Pipe. A shrinkage hole, especially a hollow in an ingot of steel.

Pipe Foundry. A foundry where the manufacture of pipes is a speciality.

Pit. A large hole in the foundry floor in which heavy jobs are cast.

Pit-Head. The surface of the ground at the mouth of the pit.

PITTED. Marked with little hollows; unsound.

PLANISHED METAL. Metal made smooth by light blows with a hammer.

PLANT, *n.* Equipment; tackle; tools. *v.* To bed in a job.

Plaster-Cast. A copy of an object obtained by pouring plaster of Paris, mixed with water, into a mould.

PLASTIC BRONZE. An alloy of copper, tin, lead and arsenic, lead ranging from 21 per cent. to 47 per cent.

PLASTIC METAL. An anti-friction metal which retains its fluidity for some time, and works well with a soldering iron. Ex.: Sn 81, Cu 8, Pb 9, Bi 2.

PLATE MOULDING. An economic process of moulding practised where there is a large quantity wanted from the same patterns. The patterns are fixed on a plate, which is interposed between the top and bottom halves of the flask in moulding.

PLATE-WALLOPER. A piece-worker at plate moulding. (Colloquial.)

PLATFORM. The charging floor of the cupola.

Platinum. One of the noble metals, insoluble except in *aqua regia.* White, non-tarnishing, very malleable, ductile and infusible; largely used in technical and chemical manufactures. Platinum is the only metal known around which glass can be fused, and is indispensable in the manufacture of electrical apparatus, such as incandescent lamps. The metal is now becoming scarce.

Platinum-Bronze. A hard, white coloured bronze. Comp.: Cu 43, Zn 22, Ni 30, Pt 5.

PLUG, *n.* A conically-shaped piece of clay, which is fixed to the button of the bott-stick. *v.* To plug the tapping-hole of the cupola.

Plumbago. Graphite; blacklead; foundry facing, which acts as a separator between metal and sand and ensures smooth castings.

PLUMP. To cast or let drop suddenly. See *Gate: plump gate.*

POCKET. A cavity in a mould; or a piece of tackle serving as an enclosure for a projecting part of a pattern from which a mould is being made.

POCKET-PRINT. A print which is prolonged to the parting-joint of a pattern, and "stopped over" after the core is fitted in its place.

POLING. A process in refining copper. The surface of the metal is covered with fine charcoal to prevent access of air, and a long pole of green wood is introduced, when a violent evolution of hydro-carbon and other reducing gases takes place and removes the oxygen. Various tests are applied during this operation, as it is one requiring extreme nicety, the result of too long continued "poling" being "over-poled" copper, and the reverse "under-poled."

POP-GATE. See *Gate.*

Porous. Spongy; metal which is permeable by liquids; unsound.

POT. A crucible; a cast-iron ladle.

POT-METAL. An alloy of copper and lead: a common cock-metal.

POURING-FLOOR. In some foundries the moulds are made in a different part of the building from where they are cast, hence pouring-floor.

Potin jaune (Fr.). Yellow brass.

PRESS. A ramming machine for small moulds.

Pressure. "A thrust which is equally intense in all directions around a point."

PRICKER. A sharp pointed wire, used for venting cores and moulds.

PRINT. A projecting piece on a pattern which forms in the mould an impression for holding in place or steadying a core.

PRINTING (Am.). See *Punting.*

PRODS. Dabbers; projecting teeth or prickers on a loam-plate.

Prove. To test, or make a trial, as in setting a loam-board or centering a core in a mould.

PUDDLING. A process in the manufacture of wrought iron and steel. The iron is subjected to intense heat and frequent stirring in the presence of oxidising substances to free it from impurities and some of its carbon.

PUNTING (Am.). Stamping: a method of closing the pores of a mould which cannot be slicked. After the facing has been dusted on, the pattern is returned to the mould and "punted" or knocked. See *Return Facing.*

Q.

QUEEN'S METAL. Britannia metal: an alloy consisting essentially of tin, with a slight admixture of antimony, bismuth, lead or copper.

Quicksilver. Mercury: so-called from its fluidity and its resemblance to liquid silver.

R.

RABBLE. A long iron bar or flapper, for stirring molten metal in the reverberatory furnace.

"RAB HA'" (Sc.). A reservoir for molten metal; usually a large tank fitted with a sluice, daubed or lined with sand. This is a common makeshift where it is inconvenient to cast with ladles, or where the ladle capacity is too small. Robert Hall was a notorious glutton. See *Gathering Metal*; *Dam.*

RACE. A sloped bed of sand in which wedges and rough tackle are sometimes cast.

Radius. The semi-diameter of a circle.

RAG. A barb: an irregular fin or ragged edge on a casting.

Rake. The inclination of anything from a perpendicular direction; angle.

Raking-Bars. Long round bars used for drawing the residuary coke, slag and metal, from a solid bottom cupola, after the cast.

Rammer. A tool for pounding the sand of a mould to render it compact.

Ramming. Pounding sand; an operation in moulding requiring judgment, the force of the blows being tempered to suit the various thicknesses and areas of sand in a mould.

Ramming-Blocks. Plaster or metal reverse moulds used in some classes of repetition work. See *Block Moulding*.

Range. Originally a chimney rack; now used for the whole fireplace.

Rap. To free a pattern, and facilitate its removal from a mould, by a series of light blows.

Rapping-Bar. A spiked bar, which is struck to knock the pattern about.

Rapping-Plates. Iron plates, which are let into the faces of a pattern to effect the loosening of the same from the mould by rapping upon a bar inserted into holes in the plates.

Rattler. A tumbling-barrel, for cleaning the sand from castings.

Rat's Tail. A small, fine swab, tapered like a rat's tail.

Receiver. A receptacle in a furnace or ladle for holding molten iron and keeping it free from cinder, slag, etc.

RED BRASS. *Tombac.* Comp.: Cu 85, Zn 15; also a collective term for the various alloys distinguished by hardness, and used for bearings of heavily loaded and rapidly revolving axles.

RED METAL. Cock metal; steam metal. Ex.: copper 64, tin 4, yellow brass 8, lead 1.

RED-SHORT. Brittle when hot.

REDUCE. To bring to the metallic state by separating from impurities.

Refiner. One who purifies metals.

REFINING. The last process in the manufacture of the commercial metals.

Refractory. Difficult of treatment, as fusion or reduction.

REFUSE. Scum, dross, kish, scoria.

REGENERATOR. A device used in connection with gas-burning furnaces, in which the incoming air or gas is heated by being brought into contact with masses of iron, brick, etc., which have been previously heated by the outgoing air or gas—Siemens' process.

Regulus. The name given by the alchemists to the metallic substances separated from other matter by fusion.

REMELT. To melt a second time: to render metal homogeneous by remelting.

REPEAT WORK. Castings with a large number on order.

Respirator. A gauze covering, for the mouth or nose, to prevent some metal workers from inhaling noxious fumes.

Rest. A stool or support; a small beam or trestle.

Return Facing. Facing suitable for light work or delicate impressions, requiring the return of the pattern to the mould after being dusted over. The best return facing is a combination of light carbons.

Returns. Scrap metal returned from the dressing-yard; home scrap.

Reverberatory. See *Furnace.*

Rhodium. A rare metal; obtained from some ores of platinum, and largely used for pen points.

Rib. A bar or ridge of metal which tends to stiffen a casting.

Riddlings. Refuse; hard worthless material left after riddling sand.

Rig. To fit with tackle; to arrange appliances.

Ringer. A malleable iron binder, which forms a loop over the binding bars.

Riser. A feed head; an opening in a mould to allow air or dirt to ascend.

Roasting. Submitting to the action of heat and air: a process by which most of the impurities in ores are oxidised and slagged off, as silicates, etc.

Rodded (Am.). Fixed or stiffened with rods, as the wire through the centre of a core.

ROLL-OVER BOX. A moulding box which can be turned over.

ROMANIUM. An alloy of Al 98, Ni 1, W 1.

Rope Yarn. The best material for moulders' swabs.

ROTTEN ROCK. A special sand largely used in some localities for cores and hollow-ware; rotten sandstone.

ROUGH CASTING. A casting which has not been machined or tooled in any way.

RUB-STONE. A piece of sandstone, brick or emery, used by dressers to rub off the sand adhering to the surface of a casting.

RUBBING-BOARD. A piece of stick used for dressing loam moulds and cores prior to finishing with blackwash. See *Chinse.*

RULOZ SILVER (Fr. *Argent-Ruloz*). Sometimes called French silver. An alloy used by French manufacturers for articles formerly prepared from standard silver. Comp.: Ag 33, Cu 37 to 42, Ni 25 to 30.

RUMBLER. An iron barrel in which small castings are made to rub against one another by a rotary motion and clean the sand off; sometimes called a *tumbler* or a *rattler.*

RUNNER. A channel for leading molten metal into a mould, ladle, or pig-bed; also the metal left in the channel.

Run. To fuse, to melt, to escape, as when a crucible starts to run.

Run Out. A burst or leak in a mould while it is being cast.

Run Steel. Malleable iron castings.

Rust. The film of oxide which forms on iron when it is exposed to moist air; hence, by extension, any metallic film of corrosion.

S.

Sad. Sodden; heavy with moisture; damp.

Safe-Edge. The uncut edge of a smooth file.

Safe Side. On the right side; sure.

Sag. To sink in the middle; to lose firmness; to give way.

Salamander. See *Scaffold.*

Sal-ammoniac. Ammonium chloride, used as a flux.

Sal-enixum. Acid potassium sulphate: an excellent flux for brass.

Sand. Foundry sand is a variable article, or rather compound. All sands taken direct from the earth contain more or less vegetable matter, which burns out as soon as the molten metal strikes it. For this reason, facings and fireproof substances are added to divide the particles or fusible element of sand. For heavy iron castings, loamy sand, old sand, and coal dust, are generally mixed for facing the mould. Core sand usually contains flour, rosin, British gum, or other binding material. No hard and fast rules can be devised for mixing the various qualities of argillaceous or siliceous earths available for moulding; the moulder must use his judgment, and consider the nature of the metal as well as the weight of the casting.

"Sand Artist" (Am.). A sarcastic term for a moulder.

Sand-Bed. The sand-bed made by ramming about 3 inches of sand on the bottom of the cupola; an "open-sand" bed.

"Sandless Pig-iron." Iron which has been cast into metallic ingot-moulds. Sometimes called "chilled pig"; "machine-cast pig."

Sand End. That part of the foundry where only sand moulds are made, as distinguished from the loam end.

Sand Sifter. A machine for riddling sand.

Scab. An incrustation on the surface of a casting, caused by the metal washing away sand from that part of the mould.

Scaffold. An accumulation of partly fused material, forming a shelf or dome-shaped obstruction above the tuyeres in a blast-furnace.

Scaffolding. The term used when the alternate charges of coke and iron in the cupola get "hung" or wedged, so that the succeeding charges cease to fall down and melt.

Scale. The film of oxide formed on iron and steel castings by annealing.

Sconce. The topmost piece of packing used in binding.

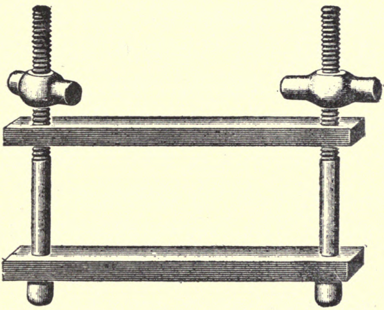
Scoriæ. The scum or dross of metals.

Scotch. To wedge, chock, or prevent from slipping.

Scotch Cement. See *Beaumontague; Filling.*

Scrap. Spillings: fragments of metal or defective castings for remelting in the foundry.

Scraper. A tool for levelling off the sand in a moulding flask.



Screw-Clamp.

Scratch Brush. A stiff wire brush for cleaning castings.

Screw-Clamp. A clamp which is threaded and fastened with a nut.

Screening. Passing foundry sand or coke through a screen.

Scum. Dross, scoria.

Sea-Coal. See *Facing.*

"SEAM-UP." To stop up the seams or joints of a mould with skilly or soft loam.

SEARCHING. Penetrating: as phosphor-bronze is a searching metal burning into the pores of a mould.

SEATING. A bearing for a core or a section of a mould; print.

Section. A division or slice of anything, or a representation of such.

Sector. A part of a circle comprehended between two radii and the included arc.

Segment. A part cut off from a figure by a line, as the segment of a circle.

SEGREGATION. The act of separating: as in the process of solidification of alloys, the heavier metals sink, or the less fusible metals set first.

SELF-DELIVERY. The delivery of a pattern leaving its own core as distinguished from one which requires to be cored out.

SET. To become solid; to solidify, as metal sets.

Shackle. A clevis, a loop fitted with a movable bolt.

Shaft. The handle of certain tools, as hammer shaft, rammer shaft.

"SHAKER" (Am.). An oscillating sand sifter.

SHANK. A ladle fitted with bars forged to a hoop for supporting and handling it.

SHEAR IRON. An attachment to the spindle used in loam moulding, and to which the loam board is fastened.

SHEATHING. Metal sheets used for sheathing vessels.

SHELL PATTERN. See *Pattern.*

SHORT. Brittle: as cast iron is said to be *hot short* or *cold short.*

SHORT CAST. A casting spoiled through insufficient metal being poured into the mould. Short-run.

Shore. To prop or support anything.

SHOT. Spillings in the form of small globular masses; also ammunition, an alloy of lead 1000 and arsenic from 3 to 8. Shot is prepared by letting fall, from a height, drops of lead into water; and an addition of a small quantity of arsenic to the lead helps its solidification, and gives to the shot a more spherical shape besides hardening it.

SHRINKAGE. The dimension lost by contraction in metals while cooling.

SHRINKING HEAD. A body of molten metal, connected with a mould, for the purpose of supplying metal to compensate for the shrinkage of the casting; also called *sinking head* and *riser.*

SIDED. Twisted; leaning to one side, as a core unequally divided, or a casting showing an uneven joint.

SIDE-RUNNER. A runner, or gate, which supplies the metal by the side of the casting.

SILICON. A metalloid which is always combined in nature. Characteristically the element of the mineral kingdom, as carbon is of the organic world. Acts as a softener in cast iron, and a deoxidiser in copper alloys.

Silicon-Bronze. An alloy of copper and silicon, with or without tin.

Silicon-Copper. The most approved flux or deoxidiser for brass alloys.

Silver. One of the "noble" metals; whitest of all metals, and best conductor of electricity.

Silver-Bronze. A German silver without nickel. Comp.: Cu 67·5, Si ·5, Mn 18, Zn 13, Al 1·20.

Silverette. Another imitation silver alloy. Comp.: Al 94, Ni 2, Cu 2, Sn 2.

Similor. A brilliant gold-like brass. Comp.: Cu 89, Zn 10·5, Sn ·5.

Sink-Hole. A cavity caused by the shrinkage of metal on solidifying: a *draw*.

Sinking Head. A riser, from which the mould is fed as the casting shrinks.

Size-Stick. A measuring stick, to which loam boards are set and cores are made.

Skids. A pair of bars which stretch across the moulding tub; stretchers.

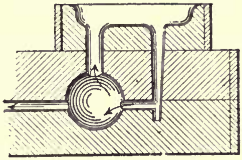
Skilly. Sand and water mixed to a soft consistence; slurry.

Skim. To clear the surface of molten metal.

Skimmer. A bent iron for skimming metals; also the one who skims.

Skimmings. Dross of metals, ashes, etc., from the skimming hole.

SKIM-GATE. A gate designed to ensure that the casting gets only clean metal.



SKIM-GATE.

SKIN. To put on a thin coat of loam.

SKIN-DRY. Partially dried.

SKINNING-UP. Putting the last coat of fine loam on a core or mould.

Slack. Small coal, or half-burnt coal.

SLACKENING. Relieving parts of a casting to allow it to contract freely.

SKULLS. The metal which sets in the bottom of the ladles after casting.

SLAB-CORE. See *Cake; Cover-Core.*

SLAG, *n.* The dross or recrement of a metal. *v.* To clear metal from scum.

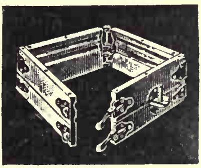
SLEEK. To make smooth. (Am.) *slick.*

SLEEKER; SLICKER. A tool for slicking moulds.

Sling. A rope or chain for suspending a heavy body.

SLIP. Fine loam; also called skinning-loam.

Sluggish. Dull, inactive. Cold metal (colloquial).



SNAP-FLASK.

SMELTING. Fusing ores for the purpose of separating and refining the metals.

SNAP-FLASK. A flask for small repeat work, the sides of which can open on hinges and leave the finished sand-mould intact; a portable moulding-box.

SNUG. See *Lug*.

SOAPSTONE. Talc: a hydrous silicate of magnesia.

Soakage. Shrinkage.

SOAKING. Allowing molten metal to remain in the furnace after it is ready.

SOFTENER. Silicon, graphite, or any substance which has a softening influence on cast iron.

Soft Solder. Plumbers' solder: Sn 1, Pb 2.

SOLDER. To unite the surfaces of metals by means of a more fusible metal, which, being melted upon each surface, serves partly by chemical attraction and partly by cohesive force to bind them together.

SOLDERING FAT. Powdered colophony and sal-ammoniac.

SOLDERING FLUID. Prepared dilute acids: "killed" spirits, used to clean the surfaces to be soldered.

SOLDIERS. Pieces of wood, used for supporting hanging parts of a mould.

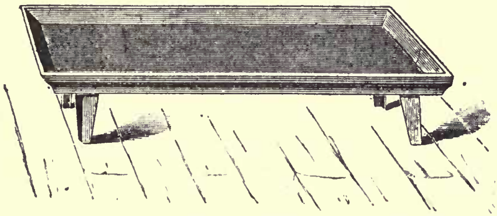
SOW. The heavy runner which conducts the molten metal into the rows of moulds in a pig-bed; an ingot runner.

SPARE. Metal over and above what is necessary for a cast.

Specific Gravity. The ratio of the weight of a body to the weight of an equal volume of some other body taken as the standard or unit; in considering solid and liquid bodies, water at 4° C. is taken as the standard; one cubic foot at this temperature weighs 62·425 lbs.

SPECULUM METAL. A hard brittle alloy, used for making metallic mirrors, as reflectors of telescopes; usually consisting of copper and tin, with a small proportion of arsenic. According to Ross, the best proportions are: copper 126·4, tin 58·9, i.e. atomic proportions.

SPELTER. The trade name for zinc; also applied to hard solder as spelter solder.



SPILL-TROUGH.

SPIEGELEISEN. A fusible white cast iron, containing a large proportion of carbon (from 3 to 7 per cent.) and some manganese. When the manganese reaches 25 per cent. and upwards, it has a granular structure, and constitutes the alloy *ferro-manganese*, largely used in the manufacture of Bessemer steel; called also spiegel and spiegel-iron.

SPILLINGS. Scrap metal spilled during a cast.

SPILL-TROUGH. A tray for catching spillings, used in brassfoundries.

SPILLY. Containing dross.

SPINNING METAL. Any malleable metal or alloy which can be shaped into a hollow form by pressing against it with a smooth tool or roller while it revolves.

SPLITTING. The method of dividing castings, as wheels, pulleys, etc., and relieving them from tension by inserting plates in the mould to effect a separation in the act of casting.

Speiss. A regulus consisting essentially of nickel; in assaying, a compound of a metal with arsenic.

Spongy. Full of cavities; porous.

SPOON METAL. The name given to the standard German silver put into cheap spoons. Comp.: Cu 50, Ni 25, Zn 25.

SPOUT. The orifice through which the metal flows from the furnace to the ladle.

SPRAY. A series of castings or patterns attached to a central runner; or a branched runner made to distribute metal in all parts of the mould. See GATE.

Spriggs. Moulders' brads for binding weak parts of a mould.

SPRINGER. A bent plate for steadying a core.

SPRUE. The hole through which melted metal is poured into the gate and thence into the mould; also the waste piece of metal cast in this hole.

SPRUE CUTTER. A machine for cutting off sprues.

SPY. To look under the cope of a mould and examine it.

Spy-Hole. An opening for looking into the furnace during the operation of melting.

Stack. To arrange in piles: as to stack boxes, pig-iron, etc.

STAKE. A piece of wood driven into the ground to stay or guide the position of a cope or top part.

STAMPING. See PUNTING.

STANG; STANGY. A piece of wire with a plate riveted on, and used as a support for a core in place of a chaplet.

Staple. A loop of iron or other metal meant to act as a stay.

STARS. Small star-shaped castings, made in very hard iron, and used in tumbling barrels for cleaning the sand off castings.

STARS.

STATIONARY-BED. A permanent open-sand moulding-bed.

STEAM METAL (Am.). Gun-metal suitable for boiler mountings. Comp.: Cu 86, Sn 7, Zn 5, Pb 2.

STEADY-PIN. An extra long box-pin for keeping a cope in true vertical position while it is being parted.

Steel. See NOTES ON MATERIALS, p. 163.

STEEP JOINT. A deep parting in a mould: a make-shift which enables the moulder to use a shallow top part for a deep joint.

Sterro Metal. An alloy of brass and iron. Comp.: Cu 55, Zn 41, Iron 4.

Stiffening Bar. A bar to prevent a pattern from warping.

STIRRER. A piece of wood, iron or plumbago, used for agitating metals.

STOP-UP. To prevent the metal from running out of the joints when casting.

STOP-OFF. To close or fill in with sand a part of the mould not required for the casting.

Stool. A rest, or small trestle.

Straight-Edge. A board used to ascertain whether a line is straight or a surface even, and for drawing straight lines.

Strain. The terms *strain* and *stress* are sometimes used synonymously, but there should be this distinction: *strain* is the alteration of form caused by force; *stress* is the force operating and tending to produce strain.

STRAPS. The leather straps used for lifting cores into the mould.

STREAKED. A defect in castings due to the careless application of blacking.

STRETCHER. See SKIDS. A distance piece, to keep a sling from chafing the work.

STRICKLE. A board for smoothing the surface of a core, or for striking off superfluous sand or loam.

STRIPPING PLATE. A device which is used on some moulding machines, to permit of deep lifts being made without breaking the edges of the mould.

STRONG SAND. Milled sand, or rock sand mixed with loam: sand which resists the cutting action of metal and does not scab easily.

Stud. A chaplet, nail, or metal support.

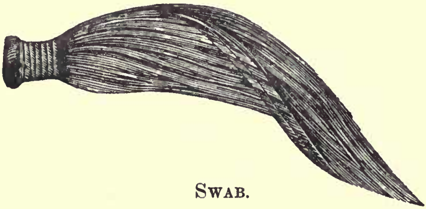
Sublimation. The deposit of a solid from a state of vapour.

SULKY LADLE. See NOTES ON APPLIANCES, p. 146.

SULLAGE. The scoria on the surface of molten metal in the ladle.

SULPHUR. A non-metallic element which is extensively diffused in combination with the metals. The chief ores of silver, lead, zinc, antimony, etc. are sulphides. Sulphur is an undesirable element in metals.

"SUN ABOUT." See FOUNDRY PHRASES, p. 114.



SWAB.

SWAB, *n.* A chinse, or a rope yarn *rat's tail*, used for damping the edges of a mould and for black-washing *v.* To wash over or make moist.

SWEAT. To liquate; to unite by heating after the application of solder.

SWEEP. A movable templet for shaping moulds in loam.

SWEDISH CHARCOAL IRON. Probably the purest commercial iron.

SWELLING. An enlargement on the surface of a casting caused by stress, or a soft place in the mould.

Swivel. A ring turning on a staple; the trunnions of a moulding-box.

Symbol. An abbreviation for the name of an element, and consisting of the initial letters of the Latin name.

T.

TABLE. A list of mixtures or charges.

TACKLE. Plant; apparatus required to produce castings, as core-irons, lifters, etc.

TACKY. Sticky, adhesive: as when a core has been newly blackwashed.

Talc. A soft mineral, of soapy feel, used as a bond in plumbago facings.

Tally. To keep count, or check off.

TAP, *v.* To draw off metal from a furnace by piercing the *breast.*

TAPPING-BAR. A pointed iron bar for removing the clay-bott when it is desired to tap the metal in the cupola.

Tarnish, v. To lose lustre.

TEEM, *v.* To pour or cast metal.

TEEMING-BOX. A hole in the floor about 2 feet deep, with sand spread over the bottom, for pouring crucible steel into ingot-moulds.

TEMPER, *v.* To moisten to a proper consistency: as sand or loam for moulding; to harden metals by chilling, as steel; or by alloying, as bell-metal, pewter, etc.

TEMPLET. See *Sweep.*

Tenacity. The greatest longitudinal strength a substance can bear without tearing asunder: *tensile strength.*

"TERRA FLAKE." A trade name for soapstone, or "white plumbago."

TEST BAR. A bar of metal (sometimes attached to the casting), which must bear certain tests, chemical or physical, before the casting is accepted. See NOTES ON TEST BARS, p. 211.

THERMAL TEST. A severe test which is generally applied to locomotive wheels. A certain quantity of molten iron is poured round the outer circumference of the wheel, and allowed to contract upon it.

"*Thermit.*" A mixture of ferric oxide, aluminium and barium super-oxide, which on ignition develops intense heat. By the application of "Thermit" (as described in *Feilden's Magazine,* December 1900), steel can be welded, and highly refractory metals like chromium and manganese can be reduced in a state of purity not obtainable by the ordinary processes.

THICKNESSING. A method of moulding by putting a thickness of sand, clay or loam, upon the core when there is no pattern, or upon the mould when there is no core-box provided. See *Boss.*

TIERS. Irons fixed on the handles of box parts to tie them together. Also called Tie-rods.

TIE WIRE. Annealed iron wire, thin and pliable.

TIERS-ARGENT (Fr. one-third silver). An alloy of Ag 1, Al 2.

TILE. A furnace cover.

Tin. A soft, white, crystalline metal which enters into many of the alloys.

TIN CRY. The creaking noise produced by a bar of tin when bent.

TITANIUM. An alloy of tin and copper used for pewter-ware.

TOMBAC. A cheap gilding metal used for common jewellery. Red brass. Comp.: Cu 86, Zn 14.

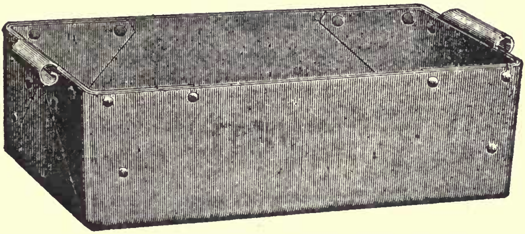
TOP-PRINT. A print placed on the top of a pattern to guide the core into its place.

TORCHED MOULD. A mould over which a torch has been held to close the pores. This is the practice with fine brasswork which cannot be faced in the ordinary way.

"TOTE-BOX" (Am.). A box or pail for carrying loam, blackwash, etc.

Trammel. A beam compass, used in drawing arcs of circles, or as a divider.

TRAMPING OR TREADING is a method of ramming which, when thoroughly understood, is of great value to the moulder, owing to the fact that upon an equal thickness of sand, a man's weight *applied at every portion* must result in an equal depression all over, and thus produce a rammed surface of equal density at every part. If this operation is not performed with judgment and care, the casting will most assuredly betray the moulder's ignorance or neglect; alternate heavy and light treading being unmistakably revealed by the undulating appearance of the casting's surface. —*Bolland.*



FOUNDRY "TOTE-BOX."

TRANSPLANTING. Drawing the pattern out of one part of the floor or flask and bedding it in another.

TRANSVERSE TEST. The transverse breaking weight, i.e. the strain necessary to break a bar of a given section placed between supports 12 inches apart.

TREADING. Ramming with the feet. See *Tramping.*

Trestles. Movable supports; the supports on which loam cores are turned.

TRICKY. A double-ended slicker for bushes or rounded surfaces.

Trowel. A tool used for smoothing a mould.

Trunnion. A journal on the sides of boxes to enable them to be rolled over while suspended on the crane.

TUB. The trough in which brass-moulders ram up small moulds.

TUCKING. Pressing the sand close against the pattern or round the *soldiers.* This is generally done with the fingers before using the rammer, but only in places inaccessible to ordinary ramming, as for example near the under portions of a pattern which is being bedded in.

TUMBLER. A tumbling barrel, *rattler*, or *rumbler.*

TUMBLING CORE. A core with a double parting, and which can be turned over with the mould.

Tungsten. A rare metal, very hard and infusible, used in steel making, and in a few of the modern alloys, as *Wolframinium.*

TURNOVER BOARD. A face board on which plain patterns are laid while the drag is being rammed up, after which it is turned over.

TYPE METAL. An alloy used for making type, stereotype plates, etc. It consists essentially of lead and antimony, with occasionally a little tin, nickel or copper. Comp.: Sn 80, Sb 20.

U.

UNDERCUT. A pattern is said to be undercut when those portions which are lowermost in the mould have larger dimensions. The usual methods of dealing with undercuts are loose pieces on the pattern, or drawbacks in the mould.

"UP." See FOUNDRY PHRASES, p. 114.

Up-end, v. To set on end.

Uranium. A metal of the chromium group, and with similar properties.

V.

Veins. Small cracks in a mould, which produce veins on the casting.

VENT. An air passage, intended to carry off the gases produced in moulds and cores when brought into contact with the molten metal.

VENT-WIRE. A pricker, for piercing sand moulds and cores, to facilitate the egress of gases formed at the time of casting.

VENUS METAL. An alloy of equal parts of copper and antimony, so-called because of its beautiful pink-violet colour. The metal is too brittle to be of any commercial value.

VERDE ANTIQUE (*old green*). A process for imparting a green finish to brass and copper goods. The articles are cleaned thoroughly from grease, finished with a scratch-brush, and dipped in a solution consisting of: vinegar, 1 quart; sal-ammoniac, 250 grains; common salt, 250 grains; ammonia, ½ oz. When taken out of the liquid a green froth begins to form on the surface; this has to be spread with a camel-hair brush, then dried with a second brush. Allow 24 hours before putting on another coat, then lacquer. Three or four coats give a deeper colour.

Verdigris. Acetate of copper, or "copper-rust."

Virgin Metal. Superfined metal. Ex.: *virgin zinc* or spelter.

W.

WASHED. Worn away by the action of the metal at the time of pouring.

WASHED COKE. Coke which has been purified by washing.

WASHINGS. Brassfoundry *tailings*, i.e. ashes which have been ground and washed, leaving the small scrap metal behind.

WASTE. Loss in melting metals.

Wasters. Bad castings.

Waste Blocks. Plaster blocks, which have served for making reversed moulds, the waste blocks being rammed directly on the pattern. See *Block Moulding*.

Water-Gilding. The process of gilding by the application of an amalgam of gold to the surface of metals; the mercury is driven off by heat, and a thin coating of gold remains.

Water Tumbler. An iron barrel, usually wood-lined, in which brass castings are packed with coarse sharp sand and water. After revolving some time, the castings are taken out, washed in cold water, then plunged into hot water, taken out and left to dry.

Weathering. The wearing action of the atmosphere on iron or other metal.

Wedge, n. A piece of metal thick at one end and tapering thinner towards the other. *v.* To fasten or tighten anything.

Weights. Pieces of iron for weighting down moulds.

Well. The lower part of the furnace into which the metal falls.

"Wet" Pot-Metal. Pot-metal saturated with lead, so that it separates from the alloy as it cools. Any pot-metal alloy containing over 28 per cent. lead is classed as "wet" pot-metal.

White Brass. An alloy of copper and zinc. Comp.: Cu 45, Zn 55.

WHITE IRON. A very hard iron, containing a large percentage of combined carbon, and having a small whitish crystal in the fracture.

WHITE METAL. Any white-coloured metal, as pewter, Britannia metal, etc., but specially in recent years anti-friction metals.

WHITE NAVY BRONZE. A good quality anti-friction metal. Ex.: Sn 78, Pb 16, Sb 3, Cu 3.

WHITE TOMBAC. Comp.: Cu 75, As 25. See *Tombac*.

"WHISTLER." A small riser used in light thin castings, so-called because of the noise made by the air escaping in the act of casting.

"WINDBAGS." The playful moulder's term for the bellows.

Wind-Gauge. A gauge indicating the pressure of blast entering the cupola.

WOLFRAMINIUM. An alloy of Al 98, Cu 1, W 1. Registered by the British Aluminium Company, Limited.

Wootz. Indian steel; supposed to be an alloy of steel with small quantities of silicium and aluminium.

X.

X or × on a pattern usually indicates something requiring attention: as some loose piece, or a screw-nail that requires to be undone, etc.

Y.

Yard. An enclosure for storing foundry materials.

YELLOW BRASS, or YELLOW METAL. The common alloy of brass, i.e. Cu 66·4, Zn 33·3.

YOKE. A crosspiece connecting two legs of a sling; a shroud.

Z.

Zinc. An abundant bluish-white metal, malleable when heated.

Zinc-White. Zinc oxide.

ZONE. A girdle or belt. See *Melting Zone.*

A SYNOPSIS OF FOUNDRY PHRASES.

WORKMEN acquire habits of speech and address which are only fit for use in the workshop. Factory "*telegraphese*" is as universal as the horny hand; and a sign even may be made to convey a world of meaning. This is as it should be, for good workmanship does not depend on fine speeches. There is no time for "kootooing," or exchanging civilities, in a foundry where work is timed on the hypothesis of everything going like the proverbial marriage bell. Alas! it is not always plain sailing in a foundry; mishaps are plentiful, but fortunately, they are not often disastrous. There are many difficulties; but few that are insurmountable. Conversation in the foundry is necessarily brief, oftentimes brusque, and generally of the importunate stamp which is wound off in deliberate monosyllables.

The reasons for these peculiarities are evident to anyone acquainted with foundry practice. Foundry tools pass from man to man, and are called for when required; moulders work very much "on their own," and have to call for help at critical parts of their work; they are also largely dependent on unskilled help for work requiring dexterity and nerve. These things do not conduce to smooth talk, and are at the root of the seeming vulgarity of foundry colloquialisms.

Melting Ratio. The quantity of fuel required to produce a given quantity of iron, in a fluid condition, suitable for the work to be cast.

Setting-point. The freezing-point of a metal.

Bear a hand (*Am.*). To assist without delay.

The blackwash will do the rest. When a dry-sand moulder is convinced that he has put enough finish on a mould, he not infrequently uses this phrase; meaning, the blackwash will hide small defects.

Shut the doors and windows. Said in irony when a moulder turns out a casting with abnormal fins.

All cast up. All the work ready has been cast, none short or left over.

Blow her down. An order for the cupolaman to finish melting.

Who had the half-inch? To a moulder this is quite a familiar and coherent question. He hears it everyday in all tones of voice. The half-inch *riddle* is really what is being sought, and it is thoroughly understood and read into the question as put.

Boat up the furnace. The cupola tender controls the supply of molten metal by *tapping* and *boating up* the furnace, according as there is a need for it in the foundry, or the cupola. The *boat* is simply a clay stopper or cone on the end of an iron rod. To "*miss the boat,*" is to allow the metal to escape after having tried to plug up the tapping-hole.

Iron to iron. That process of binding work in the foundry, by which the most unyielding and satisfactory rigidness and security is obtained.

Light the vent. An order generally given at the crucial moment of casting, to relieve the mould or core from the pressure of gases generated by the inrushing metal.

Daub the ladle. To prepare the ladle by lining it with fresh sand or loam, so that the molten metal may not attack the shell.

Give it a dry-sand finish. Literally, "Don't be so particular." Dry-sand moulders are said to slick their moulds *with a bag* when they come out of the stove: hence dry-sand finish.

Flop it in. When dull metal is used for light castings, it is necessary to force it into the moulds with a rush so that they may be completely filled. *Rush it in* means the same thing.

Brick about. In some loam jobs it is necessary to build with soft bricks (i.e. loam bricks); other jobs can be built altogether with hard bricks (common bricks); others, again, are built up with some of each kind, in such a way that the soft bricks can be cut out or "slackened" after the job is cast. This last style of building is called "brick about."

Brick and Bond. A bricklayer's term, which has found its way into the loam end of the foundry, implying that the building is *bonded* at regular intervals or courses.

Miss a Brick. This is done for the purpose of leaving a space for the vent. Ashes are filled into the vacancy.

Cast on the Bank. To make a casting on a slope or declivity.

Cast on the Flat. To cast a job horizontally.

Cast on End. To cast perpendicularly.

Lower a Tooth. This term is not indigenous to the foundry, but it is very frequently used when the crane is required to be merely moved.

Sun about. In closing boxes, the moulder makes a habit of twisting the top part from left to right, which is called "towards the Sun," so as to avoid irregularities along the joint of a casting. The sailor coils a rope "towards the Sun."

Up! An exclamation used at the finish of a cast in order to let the caster know that sufficient metal has been poured into the mould. It is sometimes important that pouring should cease as soon as the metal appears in the risers; "swells" and "bursts" are common results of neglecting this order.

All up. Finished; exhausted. All clear.

Let it go and chance it. A common phrase when there is a doubt about a mould or a core being in perfect condition for casting. Sometimes they turn out all right, but if the job is urgent the careful moulder leaves nothing to chance.

Pour slow or you'll be short. To pour a mould short is the moulder's *bête noire*. When it is apparent that he is going to risk the spoiling of a mould, this ironical injunction is usually thrown at him by some of his mates.

When you may. A phrase which intimates to the leading hand on a job that all is ready for the next move.

Steady off one. The moulder calls for help as he needs it, and also for as many hands as he requires; thus, it is a common thing to hear "*Lift off four*," "*Turn over two*," "*Part three*." All of these refer to the handling of boxes.

Spy one. Someone is wanted to look under a box and see that the mould is intact until it closed.

Bed it in. "Bedding in" is a moulding process whereby a bed of sand conforming to the shape of the bottom or underside of the pattern is prepared, and the pattern knocked down on it.

End of the Blow. The "blow" is an operation in the Bessemer process. The end of the blow is the period in which the iron in the converter is transformed into steel.

Estimated Weight. The theoretical or calculated weight. A deviation of 5 per cent. is allowed in Governmental specifications. See RULES AND TABLES, p. 185.

Cast before the damp strikes back. Many greensand jobs are skin-dried, and it is necessary to cast such moulds as soon after they are closed as possible. If they were allowed to remain over for some time, the heat on the surface would have a tendency to draw the damp from the sand, inwards, and spoil the casting.

Pound it hard (*Am.*). A steel foundry maxim. As a rule moulds for steel require to be rammed harder than for iron.

Skimmer here. A call for someone to skim the ladle while the job is being cast.

A steep joint. When the moulder has a pipe or other casting requiring to be parted in the middle, and cannot find a pipe-box to suit it, he uses a flat top part with the bars, and makes *a steep joint*, running from the level of the foundry floor to the centre of the pattern. This is a common make-shift in jobbing foundries.

Cover up. When iron is spilled at a cast, the order is to *cover up*, and keep the heat from the men round the ladle, and also to protect their feet.

A day wi' "Rabbie." (*Sc.*). A day at "burns." A facetious phrase in Scotch foundries.

The carriage waits, my Lords. This is another example of foundry humour. The carriage is a truck for holding work which has to be dried in the stove; it is loaded shortly before stopping time, in the evening. In many of the foundries the carriage is pushed into the stove by the labourers, assisted by the moulders. This is the call for *moulders* to help.

Entered! Landed! Started! These three words are used in fitting moulds requiring the crane, and mark progress in such a way that the moulder in charge of the job knows what order to give the crane-man.

Fill in. The moulder's call to the labourer to fill in a course of sand.

A rap. Someone is wanted to rap a pattern while it is being drawn.

Seam up. To loam up the seams or joints of a box, and prevent the metal from running out. This is a very necessary precaution, especially with wooden boxes, which are liable to warp with the heat, or get burned with the metal.

Eight Ounce Metal. Many of the standard brass alloys are referred to in the foundry by the number of ounces of zinc added to the pound of copper, thus: Muntz's metal is known as 12 *oz. metal*, yellow brass as 8 *oz. metal*, dipping metal as 6 *oz. metal*, brazing metal as 3 *oz. metal.* On the other hand, sheet metals are graded by the number of ounces they weigh per square foot, as for example, 16 oz. Muntz sheet, 26 oz. sheet copper, etc.

Crossing the Course. Means to break the joints in building a loam mould. Successive courses are set so that each brick shall be equally divided upon the two bricks on which it is laid.

Binding the Course is laying one row of bricks *end in*, to rest on the inner and outer course.

Levelling the Bed. In making an "open sand-bed" it is of first importance that it should be "dead level." This is accomplished by means of three straight-edges and a level. First, one of the straight-edges is packed until it agrees with the level; the other is then set at the required distance, and, by means of a parallel straight-edge, each of the ends is made to agree with the level. The sand within the two straight-edges is then tramped or pressed to the required density, leaving it full, so that by applying another straight-edge, long enough to reach across, the superfluous sand may be strickled off and leave a level bed.

Weighting down. This is an important operation, requiring good judgment and ability to calculate the lifting force of fluid metal over a given area, in moulds which cannot be bound, clamped or held down securely by any other means than dead weight. Liquids exert pressure in every direction, and molten metal influenced by gravity alone presses in all directions. The pressure per square inch is always proportionate to the depth. The total pressure is the amount per square inch multiplied into the area. Reduced to a formula this would appear as $P = W \times H \times A$, where W = the weight of a cubic inch of metal; H = the head in inches; A = area of the casting in square inches; P = pressure in lbs. per square inch.

Example.—A plate 3 feet square, cast with 12 inches of a head.

	·26	Weight of cubic inch cast iron.
	12	Head in inches.
	3·12	
36″ × 36″ =	1296	Area in square inches.
	18 72	
	280 8	
	624	
	312	
	4043·52	= Pressure in lbs. per square inch.

Note.—This is the actual pressure, but it is customary to allow extra in weighting down, to overcome the increase due to fins and the height of the ladle above the runner-box. See Neave's Rule, page 194, which gives 4320 lbs. as answer to above example.

Lost His Block. In bedding-in work requiring chaplets a chaplet-block is placed at some distance below the bed prepared to receive the pattern, to act as a solid obstruction to the chaplet stem and support the weight of the core when it has been set to the required distance. The moulder, by carelessly ramming the drag, may displace this block; when he comes to fit in the chaplet he will discover that he has "lost his block." The phrase has become a proverb in the foundry, and is applied to anyone doing a stupid action.

Keep the Head full. In pouring work it is always desirable that the runner-head should be kept full, so that no air or dirt may be drawn into the mould with the metal Runner-heads are generally made with a gentle slope, deepening towards the runner, to assist in carrying out this injunction.

Gathering Metal. "If three or four ladles are used for pouring a heavy casting, the metal is said to be gathered in that number of vessels. If a dam is constructed to collect all the metal required from several cupolas it is gathered in the dam. It is common in some places to supplement the regular melting in the air furnace by simultaneous melting in the cupola, transferring the metal from the cupola to the bed of the air furnace as fast as it melts. In the latter instance the metal is gathered into the air furnace, which, if suitably constructed, is assuredly the best method of collecting metal in large quantities."—*Bolland.*

Driven Home. Wedges are said to be "driven home" when the blows of the hammer ring on the air, or when the space between the wedge and the sconces is solidly packed.

Hard-up. In fitting cores or sections of a mould it is essential that the abutting surfaces should be as close together as possible, otherwise fins, and an unequal division of the thickness of metal, would result. Such pieces are said to be "hard-up" when they will not yield to further pressure in the direction of the joint.

MAXIMS FOR MOULDERS.

(ADAPTED FROM WELL-KNOWN PROVERBS.)

1. A bad moulder might make a good baker; if he continued to make bad ones, he could be made to eat them.
2. A good mender is always a good moulder.
3. A tool in the hand is worth two *in the sand.*
4. Always have a stand-by in case you "*miss the boat.*"
5. Better a fin than a crush; better be sure than sorry.
6. Better a burn than a bad casting.
7. Cast in haste, increase the waste.
8. "*Chance-it*" is dead; "*short-cast*" killed him.
9. Cleanliness is next to cleverness in moulding.
10. Dirt and damp can make or mar a mould.

11. Dull metal makes dull moulders.

12. If fins were only wings, some castings would need *slings,* and *rings,* and *things,* to keep them in the foundry.

13. Keep "*soldiers*" *to the front,* and *well under cover*

14. Make your *mark,* but mind *where* you made it.

15. Make your plans to suit your *plant.*

16. Manners make a man; methods mark the moulder.

17. Never prophesy till you know; be cocksure when you see the castings.

18. Nothing beats a fair divide.

19. Some moulds are like penny-pies, fitter for pork than pig-iron.

20. Spare the swab and save the job.

21. Take care of the ramming, and the cramps will take care of themselves.

22. When clay is cheap castings are dear.
Too much clay is as bad as too little clearance.

23. *Weight* tells well; the want of it tells just as well.

24. Work for love and earn your money.

25. Youth or age is but a stage; both struggle in the foundries.
Good moulders get their work and wage; the *bad* ones get the sundries.

For want of a nail a corner fell off;
For want of a corner the core came away;
For want of a core the casting was "off"—
And this kind of work I find *never does* pay.

NOTES ON FOUNDRY PRACTICE.

Moulders and Moulding.

It is no exaggeration to say that there is no craft more fascinating to the novice, or more deceiving to the onlooker, than moulding. The work looks simplicity itself, and the densest mind can always grasp the fact that when finished and filled with molten metal, the casting should conform to the shape and configuration of the mould. But, alas, this is not always the case. How often have we seen castings distorted, fractured, crushed, blown, etc. come from moulds which were models to look at. This is where a wide knowledge of the art comes in handy, for then one is able to arrive at some conclusion as to the cause of such unlooked-for and untoward happenings, and guard against them in the future. Most moulders have only their own paltry experience to guide them, and they content themselves with being adepts at one particular branch of moulding, or one special class of work. No matter how wide a man's experience may have been, he is always able to gain something by other people's experience, if he is a capable tradesman—sometimes even from people who have no knowledge of or connection with the trade whatever. The common conception of a moulder is a smutty, sweaty, sweep-like individual of low intelligence, who is able to stand up to unlimited heat and hard "graft." When we speak of a moulder, in the industrial sense, we generally mean a tradesman who makes castings in iron; it has been the custom from time immemorial to particularise those tradesmen who cast in other metals, such as brass-moulder, type-founder, steel-moulder, etc. There are also numerous subdivisions of the craft, as stove-founder, pipe-founder, bell-founder, etc. We may say in passing that brass and iron-moulders have much in common in their business, but there has been an unfortunate spirit of jealousy and antagonism brooding over them here for a long time, and we hold there is no need, nor indeed, in the modern industrial conflict, room for any such feeling. Moulding is an art, and, like all true art, it is acquired by the sense of touch and feeling. "*Sand Artist*" is a term of derision which has been coined by Americans given to sarcasm, but if a moulder is what he should be, the term is his true designation, quite independent of the metal he happens to manipulate. And "Sand Artists" are not so rare as many people imagine; we have learned of a moulder (who was also a born artist) who could put as much genuine art, both constructive and ornamental, into a common core-iron, as ever designer knew, and at the same time get through his work in good time.

To the uninitiated, the art of moulding is full of mystery, and, to be frank, many moulders, themselves clever enough tradesmen, help to make it still more mysterious through not having a proper knowledge of its rules, or by their inability to give a coherent statement of them.

For example, if you go into a jobbing foundry, present a drawing of the simplest machine part to the moulder, and ask him if there is any special way in which he would prefer to have the pattern or loam-boards made, ten chances to one he would be unable to distinguish even the contour of the casting, and if he happened to be one of the few who know a drawing from an exercise in Chinese, he would not be able to measure up the plant required for the job until he saw the pattern or boards. This is no exaggeration, and is only one instance of the need for technical training being pressed upon the budding tradesman.

Again, ask the average moulder to account for a bad casting: more than likely he will tell you he doesn't know how to account for it; or, if he doesn't wish to appear stupid, he will say he thinks it must have been due to so-and-so, or because of such-and-such; the answer is always indefinite, never a settled conclusion.

Then, how many moulders can give even an approximate idea of the weight of a casting? It is only by familiarity with castings that he is able to make a guess at the estimated weight—always rather over than under, or on the "safe side," as he calls it. No selfrespecting moulder who wished to be true to the traditions of his trade would ever dream of totting it up, yet in his own way he does a deal of calculating, as when allowing for contraction, he says this will have to be slackened, or that will require to be "fed," and so on.

Now, it is just as necessary for the moulder as it is for the engineer to study sections, areas, pressures, and all the other dry-as-dust data which have been formulated for arriving at a correct knowledge of things. Why should the moulder's part of the work be done by guesswork, or by any similar slipshod method? Moulding is a science as well as an art, and it seems a hard thing to say that the average moulder knows literally nothing of the science, and only so much of the art as will enable him to earn a livelihood at the common jobs in the foundry. How far this is true is only known to those who have travelled through the shops in the various competing industrial countries. Whether it is for want of inclination, opportunity, or intelligence to grasp the laws of mechanics—laws which the moulder, in common with all other tradesmen, observes in carrying on his daily operations—the fact remains that there is a deplorable want of knowledge regarding the cause or effect of the various actions involved in the everyday work of the foundry. It is not the want of thinking power, but the want of having the thoughts properly directed, that is to blame for this state of affairs. If one tithe of the brain-racking thought that is from time to time expended in rigging up temporary arrangements for carrying on jobs in the foundry was given to the principles underlying and governing such arrangements, the battle would be won for scientific moulding, and the day of haphazard foundry practice would be doomed. As it is, makeshifts, patching, and temporary success are the order of the day, and are about all that are looked for from the ordinary moulder.

It goes without saying that the best tradesmen are those who can see the end from the beginning, who can have a job moulded in their minds before putting a hand to the tools. Half-an-hour spent on studying a job, or in mentally measuring up its points, is often better than half-a-day's work at it on the rush. This habit of "rushing things through" is the one great blemish of modern foundry practice. There is no time to think, or to weigh the pros and cons of how a job can best be done. The foundry seems to be smitten more severely than other departments with the fever of excitement and hurry, and in most foundries one or two men who are expert in different branches are kept for the purpose of "horsing on the work." These men know their way about a particular class of work, say marine work or stoves or tools; they make the pace, the others have to follow in their wake.

Let it clearly be understood that we are not deprecating the expeditious output of good work in the foundry, but only the system which prevails of getting things done anyhow. You don't catch the pattern-maker or the machinist doing his bit on these lines.

It is a well-known fact that in timing a break-down job the manager never takes the foundry into account unless it happens to be either an intricate or weighty piece. The patternmaker gives in the quickest time in which he can do his part of the repair, the machinist and the fitter do the same, but the moulder is seldom consulted in the matter, the time for moulding being a mere bagatelle to what the other departments take, and besides, the moulder is only a "sandgroper," anyway. He is not supposed to know much.

In America, moulding has been reduced to a fine art, but the fine artist in this case happens to be a machinist rather than a moulder. Machine moulding, as practised in the United States, is a really wonderful example of what science can do for moulders and their art. True, it is only in repeat work or light castings that the advantages of machines are visible. Nevertheless there is ample scope for the application of new notions to all grades of foundry work. The primary objects of all such improvements must be to combine economy with exactness in the work produced. It seems a pity that men who are clear-sighted enough to see the advantages to be derived from the introduction of machinery in other departments of labour are not able to appreciate them in their own. Moulders award the palm to machine-made patterns, core-boxes, dowel-pins, chaplets, hay-ropes, etc.; they use these, and, indeed prefer them to the hand-made variety. Yet when it comes to introducing labour-saving machinery for foundry work, they shy and kick like ill-trained horses—all strength and no sense.

Without entering into the economics of the question at all, it should be quite patent to all such that the hands of time cannot be put back, nor the wheels of progress stopped, by an unreasonable refusal to countenance such a thing as machine moulding. The moulder's day of triumph will come when he leaves off working with makeshifts and studies the principles of his trade, and how they can be best applied, whether by hand or machine. It is notorious that, as an adjunct of the engineering shop, the foundry has not kept pace with the progress made in other departments. Time was, in engineering circles, when science was looked upon as some kind of knowledge connected with steam or the steam engine; now it is the study of electrical forces. These advances never seem to touch the pulse of the foundry, for its essential tools, the wedge, the screw, and the lever—the three strongest powers known to mechanics—are much the same as they were in King Solomon's time.

Technical education has done marvellous things in the realms of steam and electrical engineering in enabling the engineer to master the forces at his hand; it has also put the textile trades on a sound footing by establishing with mathematical exactitude the principles of design, as well as the strength and hygienic qualities of materials, and in the domain of agricultural produce it has defined what is wholesome and profitable. While all this activity in the schcol and the workshop has been taking place, moulding and foundry practice, in the smaller shops at least, have been stationary. Why should this be allowed to continue? Why not send our moulders to the technological institute as well as our machinists? Moulding is a constructive art, but the principles of construction have not been studied as they ought by those engaged in it, with the result that, as often as not, it has proved a most destructive business to all concerned—destructive of reputation and prosperity.

To sum up the whole matter, it is evident that the moulder should know drawing and pattern-making as well as foundry work or mechanics, and a course of each should be included in the technical training of a moulder. The reason why practice and theory are so often at variance in the foundry is because the founder disdains to acknowledge the utility of theoretical formulæ, and prefers to work by "rule-of-thumb." We cannot hope for anything but clumsy, inaccurate, and unreliable work until we have educated him out of this state of "lofty ignorance" by some such course of training as we have indicated.

Foundry Management.

Foundry management is as open to reproof as foundry methods. The management of any business is the primary cause of its being. The work produced may be meritorious, the conditions commendable, but unless there is some system of securing and putting through orders, these things go for next to nothing. Nothing grows haphazard, not even weeds ; and business weeds less than others. There is a system at the root of all growth. In no department of a business is the pulse sooner felt than the managerial. Britain has reached her high place amongst the industrial nations by a happy combination of good management and good workmanship. Strange to say, the foundry is more liable to mismanagement than any other branch of engineering. The reason is not far to seek. Budding works managers are compelled to undergo a practical course in the drawing-office, the pattern, fitting and machine shops, but their knowledge of foundry matters is left entirely to the theoretical points of moulding. The result is, they are at the mercy of foremen or workmen (who have little or no theory) for successful schemes, and often in ignorance of the practical difficulties, managers undertake utter impossibilities. We have met with many instances of this, and from time to time we have pointed out, from the practical aspect, some of the things in the foundry requiring the attention of those interested, such as better equipment, a fuller knowledge of the principles involved and the materials wrought with, etc., as it is along these lines that the actual progress and improvement of foundry amenities must come, and the average tradesman does not trouble to reason why certain things are not what they seem.

"The leaders of Industry, if Industry is ever to be led, are virtually the Captains of the World."

Industry offers an open field to everyone who will enter, but all who aspire to be captains of industry must be willing to recognise the rules of the fight for mastery in the industrial arena. They must possess, in addition to the qualifications characteristic of leaders, ability to take part in the industrial development of the world, and an even temper. Enterprise and good luck have made many men successful in business, but self-confidence and vigilance do not always spell success, for many a bold venture, launched with *éclat* and pious hopes for the future, has ended in dismal failure. The success of any undertaking is, first and foremost, a question of management. Without a doubt, the manufacturing industries are more liable to suffer loss through laxity or mismanagement than the purely commercial or economic agencies. The reasons are obvious: Labour and material are required to produce commodities, and unless there is alert administration and careful handling of both, leakages occur which are bound to have a baneful effect on the health of even the strongest concerns; on the other hand, where the business is simply of an intermediary nature, the risks are fewer and more confined, and errors, when they do occur, can be readily detected and remedied. The mind of the "middleman" is not distracted with the problems incidental to manufacturing operations, but is free to ruminate on the final objective of all trade—viz. buying and selling at a profit.

The subject of foundry management has not received the attention it deserves. It is quite notorious that in large engineering establishments, where founding is included as an auxiliary branch, the foundry is invariably behind the other departments in equipment and facilities for getting work done. We cannot understand why works managers, who are generally clever financiers, should not value labour-saving appliances in the foundry as well as in the machine shop. A shilling saved in the foundry has the same currency as one earned in any other department. Besides, whatever economises labour or material in a workshop is worth having, and in the matter of foundry plant or equipment, a small and seemingly insignificant alteration may have very great results. This is the day of keenest competition and commercial activity. Success to-day depends on ability to maintain the rapid pace set by modern inventions and competition, and up-to-date traders demand the best article you can produce for a fair price. But many firms do not know the cost of producing the goods they manufacture, and it has been proved that in foundries where books are so kept as to show only the result at the end of the month or year, it is quite possible to make a large number of castings which cost more than they bring.

In the management of the foundry there is nothing of more importance than to have a correct system of prime-cost summaries, which must tally with the total of the balance against the commercial books. That is to say, the total amount paid for labour, as given in the prime-cost summaries, must tally with the total of the wages book and cash book. In the same way, the total value of material must tally with the total purchases in the day book, plus and minus the amount of stock at the commencement and end of the period dealt with. A continuous record of these matters, taken day by day, will enable the manager to find out where time is being wasted and where economy may be effected by improved methods. As an example of this method, we copy a blank page from the cost record of a highly successful firm in Scotland :—

THE C......... FOUNDRY CO.

MOULDER NO.......　　　DATE.......................

JOB NO.........

TIME.	RATE.			METAL.	RATE.			SUNDRIES.			ONCOST.
Hrs.	£	s.	d.	lb.	£	s.	d.	£	s.	d.	%
TOTAL											

ABSTRACT.

	£	s.	d.
Labour	:	:	:
Material	:	:	:
Oncost	:	:	:
Total	:	:	:
Charge	:	:	:
Profit or loss	:	:	:

Here the oncost is arrived at by a system of averages derived from work already done. By adopting the law of averages, and allowing a fair margin for profit, there can be no serious discrepancies. It would be quite impossible to allocate charges in grouped detail for foundry work. A moulder may be employed on two or three jobs at once, and it would add greatly to the office expenses to find the proportion of coke, coal, oil, etc. chargeable to every little job.

Viewed in this broad sense, the economics of the foundry are easily fathomed. The essential points to remember are: First, to consider whether the risks—speculative or operative—are sufficiently remunerative to pay the expenses of production; second, to detail all expenses; and third, because of the waste in working metal, fuel, sand, etc., the success of the foundry business is regulated altogether by the output, and greatly depends on the capacity of the shop being fully occupied. Everyone has his own ideas as to how a business should be managed. Without dogmatising in the matter of foundry management, this may be said, that the founder might with profit both to himself and his customers display a little more intimate knowledge with exact science in so far as it relates to his trade. Science and skill are as much in demand in the foundry as in any other branch of engineering. It has been well said that "There is nothing in the way of mechanical arts or sciences that requires more thought, more mechanical skill, and more skilful practice. In all the other trades there are rules, tables, gauges, and fixed systematic order that can be, and are, applied to the different requirements. All these fall short when you come to apply them to moulding, as that is learned almost entirely by the sense of feeling." While there is no such thing as a standard system of works organisation, or cast-iron methods of managing a business, it is now generally recognised that some system of order and despatch is imperative. The whole question, of course, resolves itself into one of cost and selling price, and nowadays, if you are anxious that your work shall remain a permanent advertisement, you must offer the best quality at a price that will command consideration. The man who sells anything wants to sell not only to-day, but to-morrow and the next day, and he can make more money out of his business if he enters into the true spirit of it. Many splendid structures have brought to their creators little more than fame; but fame built on the basis of excellent work is better for business than money reaped by jerrymandering.

In a business like moulding, there is always the certainty of an occasional disappointment. There are so many conditions conducing to perfect work that at some time or another failure is bound to overtake the very best of moulders. The most successful moulder is he who makes the best use of his failures; and while, with some things, it is essential that he "try, try again," it is also essential that his trying should be combined with some reasonable alteration in method or material. One of the greatest drawbacks to the spread of knowledge in the foundry is the modern tendency towards specialisation. To be able merely to enumerate the ordinary branches of the moulding industry in present vogue, is in all probability an accomplishment beyond the power of the bulk of foundry workers. The average moulder is uninformed and oftentimes negligent regarding the departments and processes outside of his own particular sphere in the foundry. How few, for example, understand the intricacies of "*La cire perdu*"—i.e. the wax process for making monumental and ornamental bronzes—or the possibilities of French sand? And whoever heard of a moulder who could reckon by mere figures the weight required to keep a mould intact during the cast? If we have been able to awaken an interest in these and kindred subjects, even although we have not elucidated them, we shall not have failed in our object in this work.

The Jobbing Foundry.

In planning a foundry, the first thing that falls to be considered is the class of work it is intended to produce. This matter is easily determined in some parts where the specialisation of industries has made it easy to drop into a given line, and work that for all it is worth. The existence of a jobbing foundry depends on its ability to face any job that may turn up.

The first requisite of such a shop is a good yard; by a good yard we mean one laid out with sheds for storing sand, loam, soldiers, coal, etc., and a light railway for running boxes, plant and castings in and out. Too often the yard is the last thing thought of, and as a result we have the foundry floor in a constant state of chaos. The external view of the foundry is seldom inviting, but when debris of all sorts is allowed to accumulate inside, there is no beauty anywhere, and although debris is a necessary evil in a foundry, we fail to see why it should be omnipresent.

The state of the foundry floor reveals, in a great measure, the system of conducting the operations of moulding. When we see promiscuous piles of sand, scrap bricks, box-parts, "gaggers," and core-tackle, spread all over the place, we have evidence of the absence of method, and it will generally be found in such a foundry that every man is a law unto himself, and is expected to make shift for himself, rather than to consider the general advantage of the work or the output.

It is a common mode of expression to refer to the "loam-end" or the "sand-end" of a foundry. The foundry floor should be subdivided into sections suitable to the nature of the work to be done. By such an arrangement the "sand-end" would have two sections —viz. the "bedding-in" section and the "roll-over box" section. Boxes and tackle would accumulate where they were most wanted, the hard part of the floor would be definitely located, and much of the preparatory digging and ramming would be avoided.

The next thing of importance is the crane. This should be an overhead traveller, capable of reaching any part of the foundry in six-eight time. It matters little whether it be propelled by steam, electric, hydraulic, or hand power, so long as it runs smoothly and lifts steadily. That reminds us that the walls must be built with strong butts, or cast-iron columns may be fixed in position to support the rail on which the crane runs; the wooden beams so often used in foundry construction vibrate too much for satisfactory work.

The pit should occupy the centre of the shop, and if it is a new foundry that is being laid out, it will pay to build the pit with brick, and bed it with concrete. There will be no trouble then with the "bank" giving way or "water" coming in. Many modern foundries have the pit all along one side for the sake of economising space. This is a good plan where it is convenient to run a trolley track parallel with the pit. Boxes and plant can be run right into a job without interfering with the legitimate work of the crane, and iron can be distributed by trolley with less waste and less danger than by shanks. Every foundry, large or small, should have a stationary bed for open sand work; even if no castings are made, but only core-irons or tackle for the foundry, there will be an appreciable saving of time in levelling out beds. A good plan, where space is a consideration, is to hinge a frame to the wall by means of two eye-bolts and a pin. This frame can be raised or lowered as required. It is set so that when lowered it is level ready for using, and when raised it stands against the wall out of the way. The shop should be arranged with small side doors convenient to the yard, and it must be well lighted and ventilated. The light should enter by the sides only, with windows movable from the inside, and a spacious louvre made to run the whole length of the building. The core-bench should be partitioned off from the main shop, and have racks for holding core-boxes, irons and finished cores. A stove for cores alone is a positive necessity in a jobbing foundry, and the carriage-way of the main stove should be as wide as possible so as to distribute the load and save packing. The cupola is best placed near the centre of the building, with only the tapping hole inside, to be handy for pouring work on any part of the floor. The office ought to be outside of the foundry, preferably on one side of the gateway, with the dressing shed on the other. This arrangement is found to be convenient for despatching castings and receiving stores, etc.

After all these points in planning the general arrangements of the foundry have been attended to, there remains much to be done in designing plant and appliances suitable for jobbing work. There can be no such thing as an ideal jobbing foundry, but there are many ideal tools and materials which only require to be brought under notice of practical moulders to be appreciated.

NOTES ON APPLIANCES.

Moulding Machines. There is a rapidly increasing tendency to transfer the burden of labour from the hand to the machine. The stress of modern competition has made it imperative that no opportunity be lost of minimising or economising labour.

In moulding, a certain amount of intuition, coupled with deft-handedness, is required, so it is only where rigid accuracy of motion, or purely automatic methods can be adopted, that machines for moulding purposes are able to make a show. There will always be a demand for skilled moulders, as there are operations in the foundry which no machine, however highly developed its mechanism, will ever be able to perform. Nevertheless, moulding machines have developed possibilities in the hands of American founders, which, but a few years back, were never even dreamt of. Two things are evident regarding moulding machines: first, that they are only economical where repeat or specialised work is wanted; and secondly, that they are only convenient for comparatively small work; heavy work having irregular contour, or requiring graduated ramming, is better done by hand. The advantages of moulding machines in speciality shops, are: the saving of hand ramming, a perfectly vertical lift or withdrawal of the pattern and prevention of broken moulds, the elimination of skilled labour, and economy of time, or its equivalent, increased production.

There are many types of moulding machines in vogue, fixed and portable, operated by hand, steam, pneumatic, or hydraulic power. Some of them are simply presses, others are designed chiefly for drawing the pattern, others again combine both these features; but as a rule the more complicated a machine is, the less fit it is to stand the wear and tear of manipulation in the foundry. Probably the highest point towards perfection has been reached in this department, in Gear moulding machines, by which toothed wheels, of almost any diameter or outline are moulded, and duplicated more accurately and uniformly than those made by hand. It would be quite impossible for us to describe here the merits of the various types of moulding machines. And those who are interested need not lack information about them, as there is keen rivalry amongst makers for the trade.

Cupolas. The proper construction and management of cupolas has been the subject of much discussion and inquiry. There are so many things to be considered in laying down foundry plant, that no one can say what particular type or style of cupola is best for general work, irrespective of the fuel used or the condition and quantity of the metal required for the heat. The old-fashioned bottle-shaped solid-bottom cupola is fast dying out, and giving place to the straight, lofty, drop-bottom style which is universal in America. A comparison of the relative drawbacks and advantages of cupolas having solid bottoms, collecting the metal in their own hearth, and those having drop bottoms, or having separate hearths and receivers, shows that the former are less expensive to erect, less costly in upkeep of lining, etc., and require less fettling daily.

The tuyeres of a solid-bottom, or self-contained cupola, however, have to be placed high enough to allow a body of metal to be collected, and this causes the coke bed to be higher than is necessary in a cupola having a receiver or separate hearth. Cupolas having receivers allow a more perfect mixing of iron, as a large quantity may be collected in the receiver with no risk of iron or slag getting into the tuyeres. On the other hand, a given quantity of coke will produce hotter metal at the tap-hole of a self-contained cupola than will be tapped from one having a receiver. One material advantage the drop-bottom has over the solid bottom is that the contents of a cupola may be withdrawn in two minutes without any effort worth mentioning, as when more iron has been charged than is necessary to cast the work on the moulding floor, the heat can be stopped at any time by tapping out what is melted, turning off the blast and dropping out all the unmelted iron and unburnt coke in the cupola. This can be quenched and used again the following day. Another advantage of the drop-bottom is the easy access it gives to the interior of the cupola for fettling purposes. There are a great many points in the construction of cupolas about which even the most experienced foundrymen differ, as for example, whether separate tuyeres or a "belt" are most efficacious, whether small charges or large produce the best iron (which means restricted or enlarged capacity in the bed for holding a quantity of molten iron), whether double rows of tuyeres are any advantage, or whether the variation of volume or moisture of blast has much to do with irregularities so largely found in melting. The exact location of tuyeres and charging door, proper size of delivery pipe and pressure of blast are also subject to variable interpretations.

One foundryman says, "The secret of being able to run long heats and of having a clean drop, lies in having tuyeres so high that they can not only hold what iron is necessary for a tap, but also a distance of from 6 inches to 16 inches between the slag hole and the bottom of the tuyeres."

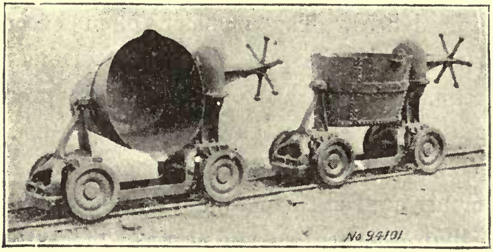
Another says, "The distance from the tuyeres to the bottom of the charging door is given as 15 feet; but my experience is altogether different from that. I think the cupola should be charged from 10 to 13 feet, instead of right up to the door. If the cupola is charged up to the door you cannot get a good biting blast, and that means slower melting and higher melting ratio." This sort of thing could be quoted *ad infinitum,* without making one any the wiser, or getting any nearer the "acme of science in cupola construction."

Every practical foundryman knows that the location and area of tuyeres have a deal to do with high melting efficiency, and may be trusted to adopt the system best suited to his mode of working. To sum up, a cupola which collects the metal in its own bottom will melt metal more economically than one having a receiver, but will require higher personal skill in management to produce well mixed iron. A cupola having a receiver takes more fettling to keep in order, is not so economical of fuel, having a larger body of brickwork to heat up, but gives more perfectly mixed iron.

Cranes. The crane is one of the most important appliances inside the foundry, and one which may be the cause of much concern or satisfaction at certain critical moments in the day's work. In large foundries overhead cranes (of which there is a great variety driven either by hand, steam or electric power), are practically indispensable.

Wall cranes, hydraulic or hand driven, are useful auxiliaries for relieving the main crane and allowing the smaller work to proceed without interfering with the progress of unwieldy jobs. It is desirable to have a crane equipped with all the necessary motions, *and* *double trolleys.* In many cases a ladle can be suspended on each hook, which will amount to having two cranes. We have seen a large foundry with six jib cranes in the length of the shop, occupying space where moulders might have been working, and keeping a squad of labourers on the "*grind*" passing boxes and castings from one to the other, out and in the shop. Such a sight is not very elevating, and to the man who is compelled to wait on such contrivances it must be depressing indeed. The moulder often encounters difficulties and troubles in the course of his work, which require a good deal of scheming to overcome. Most of these are due to the want of proper tools, and as often as not the crane is one of them. Electrically-driven cranes are fast superseding all other types owing principally to the freedom and accuracy of control and general efficiency and economy. The details of crane construction is an engineering subject, and we leave it to those best able to deal with it, resting satisfied that this most essential part of the foundry equipment will receive the consideration it deserves from progressive foundrymen.

Ladles are not the least important part of the equipment of a foundry. Handy ladles are a delight to the moulder, or the man who has to carry the iron for the best part of an afternoon. The ladles in a foundry are as various in size and design as the work to be cast. Beginning with the smallest, we have the hand ladle in sizes holding from 7 to 28 lbs.; the shank ladle—the capacity of which averages 100 lbs.; the double shank, which is somewhat larger; and the geared-ladle, which is made in different sizes, to hold almost any quantity. In some foundries the small ladles are simply cast-iron pots fitted to a shank, or band with handles. These "pots" are very clumsy and weighty. Other foundries have malleable iron ladles, with riveted rims and sides, but the up-to-date foundries



CAR-LADLES.
Made by the C. W. Hunt Coy., N.Y.

go in for seamless steel ladles, which are of much lighter gauge than any other make.

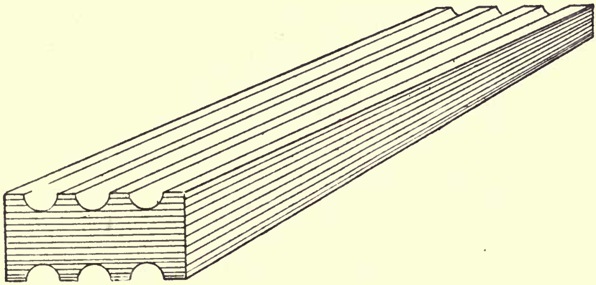
In geared ladles again, there is also plenty of variety. There is the single gear ladle, the double gear ladle (which can be worked either from the back or side as required), the car-ladle, convenient for distributing iron, or pouring into hand ladles; the reservoir or self-skimming ladle, having a metal partition inside the pouring lip extending nearly to the bottom so that the metal is drawn from underneath the surface and only clean iron poured; lastly, there is the geared trunnion ladle, which is used for the very heaviest class of work, and is generally mounted on a carriage. The main thing in foundry ladles is to have them nicely balanced; top-heaviness is a common failing, with the result that much metal is wasted and frequently men are burned. When a ladle gets worn in the journals, and out of control at some part of the traverse there is always the risk of an accident, either to the mould or the men, coupled with the certainty of making unnecessary scrap at a cast. Good ladles give the men confidence in casting, bad ones are always a source of anxiety. To run a foundry without a complete assortment of ladles is "penny-wise" economy; and those who have heavy castings to make cannot afford to run the risk of losing them for the small cost of an improved ladle.

In addition to the standard ladles already referred to, there are special kinds for special work, as bottom-pouring ladles for steel foundries, and ladles with detachable lips, or extension rims, for increasing their capacity, etc.

Magnetic Separators. Many of the tools and machines now in use in foundries have been the outcome of exceptional conditions. There certainly is an immense need and desire for any kind of appliance which will help to simplify or ameliorate the conditions of labour in the foundry, as well as an insatiable longing for "up-to-date" machinery, i.e. economical and profit-saving machinery. Amongst the latter, the familiar magnetic separators must be assigned a foremost place. Originally invented for the express purpose of extracting iron from brass borings, they have now reached a point in design and application which, in a word, must powerfully impress us with the latent possibilities of electricity and pneumatics in the progress of the industries. Many improvements and new uses have been found for separators. The old-fashioned multiple magnet and brush machine with hopper and shute is almost obsolete, and the later styles include contrivances such as disintegrators, knives, screens, and wire-straightening adjustments, which were not thought of before, and which, to use an Americanism, have made it a pleasure and a profit to deal with the foundry offal. There are two types of separators in general use; those with permanent magnets, and those with electro-magnets. By the use of electro-magnets demagnetisation is secured by a cut-off device, and the iron is much more easily released than from permanent magnets, which are cleaned with difficulty.

General Remarks. As we are not writing a text-book on foundry appliances, but simply a running commentary on some modern features, we shall pass from this subject when we have mentioned one or two other apparatus, which have almost become indispensable in the modern foundry. Some of them have been well considered and worked out in several very practical forms, as for example tumbling barrels—hexagonal, ribbed, eccentric, cylindrical and elliptical; sand-sifters

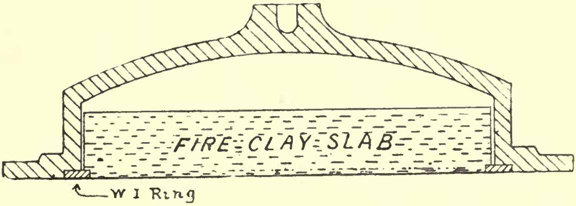
—centrifugal, oscillating and vibratory; core-making machines—on the continuous plan and with dies; sprue or gate-cutting machines—for hand, foot, or power working of brass and soft-metal castings; ramming machines, for heavy work as ramming up pits or large boxes; pneumatic hammers and chippers, etc. These things have grown with the foundry business, and it is an easy matter to predict that other improve-



GROOVED WEDGE FOR FOUNDRY USE.

ments will follow. Besides these there are many minor tools deserving the attention of practical foundrymen. The wedge, for example, is an ancient device which has not received much study from the tradesmen. The loss of a propeller blade through a wedge "skidding" while casting was the occasion of the following improvement.

A Grooved Wedge. The wedge is perhaps one of the most useful accessories of the moulding shop, as nearly all kinds of foundry work require cramping or binding in some direction. Grooving the surface of a wedge is something of an innovation, and though the principle of relieved surfaces is often met with in the fitting and turning shops, it is seldom thought of in the foundry. The illustration shows a new style of wedge, with longitudinal grooves, and made in malleable iron—a very considerable saving over forging. The faces give a better grip than the ordinary flat wedge, and with less tendency to rebound.



IMPROVED FURNACE COVER.

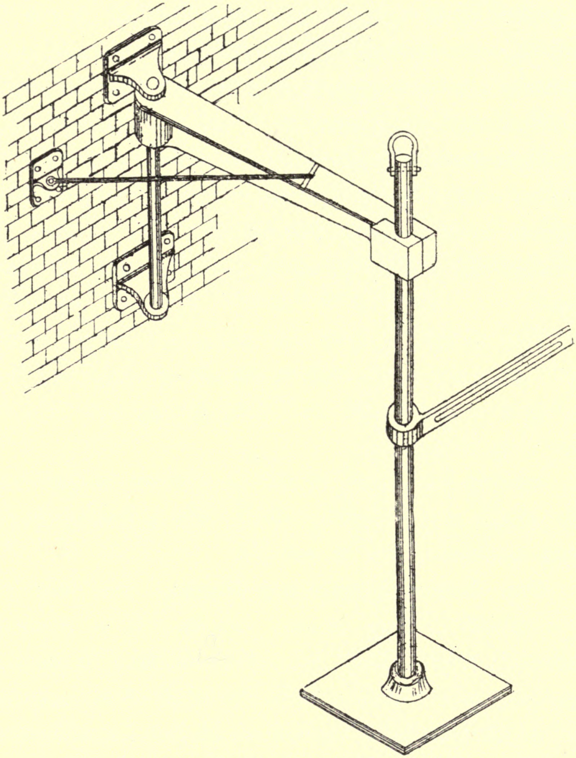
Another little improvement which adds greatly to the convenience of handling crucible furnace covers in brass and steel foundries is here shown.

An Improved Furnace Cover. The general type of air-furnace cover consists of a circular or square cast-iron plate ribbed on the top side and with a central lug for lifting or sliding it into position. This form of cover, after some little time, becomes distorted and ceases to be of much service. The illustration shows the section of a composite form of cover, the cast-iron dome enclosing a fire-clay slab, kept in position by a wrought-iron ring held in recess by countersunk screws. The arrangement is applicable to furnace doors hung either in a vertical or horizontal position, and although the initial expense is a little more, they soon pay for themselves by the more efficient working, there being less absorption of heat and less liability to twist the cover, whilst the renewal of the fire-clay slab is only necessary after a couple of years' use.

The mould for a circular dome is readily "struck up" in green sand with a couple of strickles, thus saving cost of pattern, also slabs of any size to order are easily obtainable.

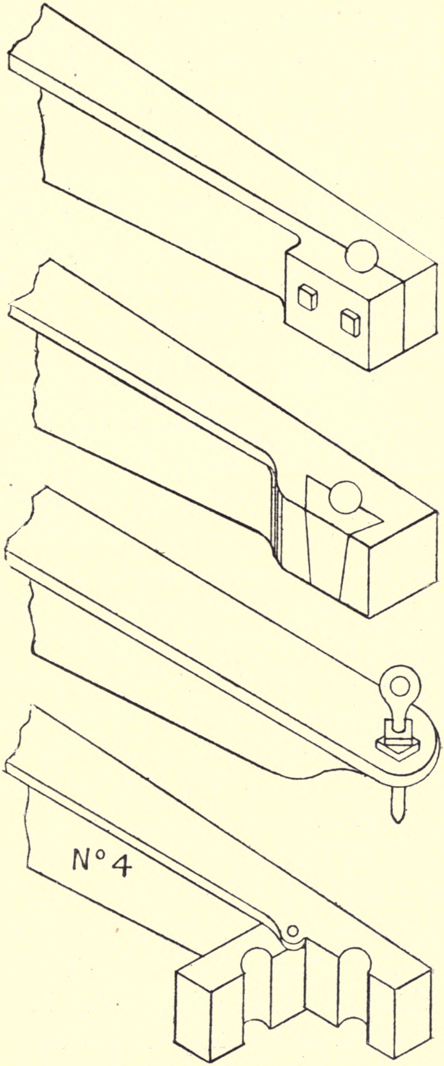
Also by permission of the proprietors of *Feilden's Magazine*, a description (with illustrations) of the loam moulder's horse is inserted.

The Loam Moulder's Horse. The horse or top spindle-bearing shown overleaf is a common feature in any foundry doing loam work. Its average height from the floor to the top is about sixteen feet and its distance from the wall eight feet, but variations are made to suit the different requirements. The horse, when in use, is kept in exact position—after the loam spindle has been set vertical with plumb-rule—by a tie rod, one end of which is fastened to the wall, leaving the other to drop into holes at set distances or one about midway of the arm. It is free to slide on the spindle, which, in turn, is supported by wall brackets as shown, and is usually locked in position by



LOAM MOULDER'S HORSE.

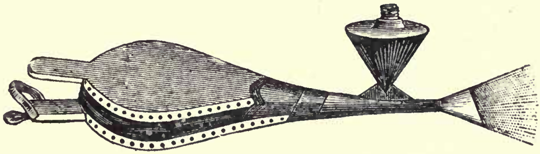
a set-screw. The various methods employed to secure the top of the main spindle are shown on the next page, the most effective and least troublesome being the hinged end, No. 4. The illustration shows the cap pushed back for the admission of the spindle. The cap is kept closed by a catch fastened on the end of the



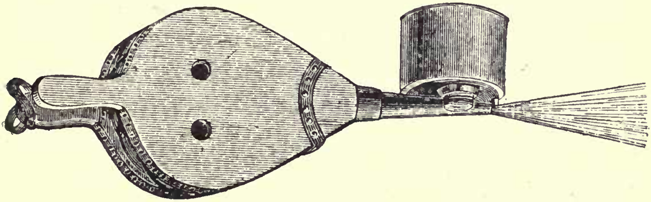
LOAM MOULDER'S HORSE.

arm, a light staff being kept handy to release it when it is necessary to remove the spindle. The arm or gudgeon on the main spindle is kept to the required height by a collar on the underside.

There are many little conveniences and improvements in foundries which have been of immense advantage, but which for want of being set forth or acknowledged by the proper parties are allowed to remain in obscurity. This is the kind of thing which tends to retard good foundry practice, and also the reason why so many ingenious individual and local ideas never pass into the general practice. We remember having seen a portable "head box" designed for casting liners or perpendicular work; it hooked on to the side of the moulding box; the metal being led in between the bars there was no sand round about the core, and there was perfect freedom in building. In another place we found an arrangement for sweeping propeller blades of any pitch, with a horizontal instead of a vertical spindle. Another useful appendage was a swivel attachment to turn over boxes of various dimensions in a "tub" (such as are to be seen in brass foundries) without the aid of a crane or other assistance. There must be hundreds of these little conveniences and novelties scattered round the various foundries which never get beyond the primitive use for which they were designed, but which if known might be improved upon and made serviceable to the trade in general. Anything that helps to take the hard work away from the men in the foundry is sure to be profitable, as it leaves them free to give their strength and attention to other matters, and results in a higher



Facing Bellows.

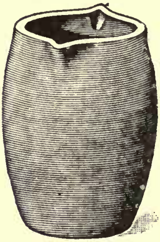


Sprinkling Bellows.

standard of excellence in the work performed. Just lately we noticed in an American foundry catalogue, an improved bellows for distributing dry facings where they cannot be applied with the dust-bag, and for spraying moulds with water, kerosene, blackwash, instead of swabbing them.

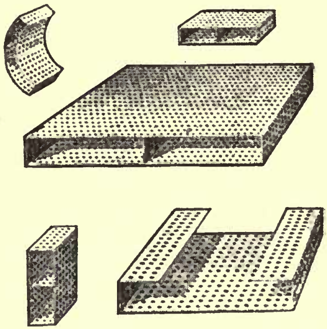
These facing and sprinkling bellows attachments show considerable ingenuity, and are sure to be appreciated by the moulder engaged on deep or delicate work. Crucibles for melting brass are now made with two pouring lips instead of one, with the advantage of more uniform wear and less bother in cleaning the lip.

Flexible leather fillets for tacking on to patterns are a great advance on the wood fillet; they can be applied to any corner, and are as easily handled upon a compound curve as in a straight line. The moulder who gets a pattern with pencil lines marking off a fillet, knows he has a cheap job on hand, and cannot be blamed if he is not so careful of the pattern as he might be. It is little things like these which add to the profit and pleasure of foundry work, and the firms which provide the best appliances have generally most satisfaction and success in their work.



FOR MELTING BRASS.

We all know that objection exists to the use of chaplets wherever it is possible to avoid them. This is as much on account of the lack of union which is likely to exist between the chaplet and the metal which surrounds it as to the marred appearance of the casting. By the use of the perforated chaplets herewith shown most of these objections are overcome.



THE PEERLESS CHAPLET.

NOTES ON MATERIALS.

Abrasives. The use and scope of abrasives has received enormous impetus from the introduction of machinery and steam or other motive power in the foundry. Castings used to be cleaned or "fettled" by hand with files, and polished by slow processes and muscular exertion; but since the discovery of "tumbling barrels," emery wheels, carborundum, and sand-blasting machinery, files, although still of great use in holes and corners, have had to take a back seat in foundry work.

Emery Wheels are made in various grades, and are extensively used for all manner of grinding and sharpening purposes. The two principal kinds of emery from which the wheels are manufactured, are the Turkish and the Naxos. The former stone (or rock) is found near Smyrna in Asia Minor, while the latter—which is supposed by experts to be of a much superior quality—comes from the island of Naxos, in the Greek Archipelago. After being imported, the stone is crushed by means of powerful breakers, and then bolted and sieved by special machinery into various sizes or grains, ranging from 6 per inch down to 200 per inch. The wheels are formed by the application of hydraulic pressure, and then undergo a process of vitrification. They are thus made very compact and strong; but the success of emery wheels depends to a great extent upon two points, viz. running them at correct speed, and being properly mounted.

Carborundum is practically a manufactured mineral made of coke, salt, sawdust and common sand fused at an intense heat by the use of the electric furnace. The ideal abrasive is one which is hard enough to withstand the hardest of materials; that will break when too great a pressure has been brought to bear upon it, and one which, when it breaks, leaves sharp irregular crystals. These characteristics are all contained in carborundum. Besides being an ideal abrasive, it is also the most powerful flux and softener of cast iron at the service of the foundryman. It enables him to use mixtures carrying large portions of scrap and obtain solid castings. As manufactured by the Carborundum Company, at Niagara Falls, the commercial article contains certain impurities. An average analysis is as follows:—

Silicon	62·	per cent.
Carbon	35·	,,
Iron	1·5	,,
Aluminium	1·5	,,
	100	

Crude carborundum, as taken from the electric furnace, usually consists of large masses of crystals. Frequently these are exceedingly beautiful in colour, and of adamantine lustre. Grain carborundum is produced by crushing and grinding the crude, treating with acids, and separating by sieves into various-sized grains. These are numbered, the same as emery, according to the number of threads per lineal inch of the sieve through which they pass. Powders are the particles too fine to size by sieving; they are graded by floating in water. Wheels are made by the vitrified process, the same as is employed for making emery wheels; but as carborundum is 23 per cent. lighter than emery, they can be run at a higher speed with less risk, the breaking strain being proportional to the weight. Carborundum being insoluble in water, oils, or acids, absolutely infusible, in hardness only exceeded by the diamond, and sufficiently brittle to permit of its breaking into sharp, angular particles, is an ideal material for grinding wheels, or the general purposes of abrasion.

Sand-blasting is an old process in glass decoration and other arts, but it is only recently, and chiefly in America, that it has found its way into the foundry.

Compressed air plays an important part in many modern appliances: the sand-blast is one of them. For cleaning scale from iron or steel, or putting a face on iron or brass castings nothing could be finer. It is far and away superior to the messy "pickling" process, being much less laborious and more expeditious. By a simple tank arrangement, and a regulating lever, the sand is forced by air pressure through a hose with a rose connection, and squirted into crevices in castings that would be difficult to reach by any other method.

Facings. The application of some adhesive and *partially* combustible material to the surface of a mould is a *sine qua non* for smooth castings in the foundry. Among the materials which have proved useful in this respect, are flour, rosin, pease-meal, lamp-black, talc or soapstone, and plumbago. These facings, as they are called, may either be used alone, and in a dry condition, or mixed with some argillaceous or glutinous liquid, as clay-water, molasses, sour beer, or certain resinous oils. The primary requisites of a good facing are, that it should adhere well and also stand a high degree of heat without disintegrating or forming a slag on the mould.

Plumbago is the favourite foundry facing. The finest quality, so far as purity is concerned, which also analyses highest in carbon and stands the highest fire-test, comes from the island of Ceylon. The celebrated Cumberland leads are monopolised in the manufacture of pencils, and are beyond the price permissible in getting out castings. Quantities of an inferior grade are found all over the world, chiefly in the United States, Canada and Germany. Owing to its greasy nature, plumbago is a very difficult mineral to grind and bolt finely. The pure material is never used for facing by itself; it requires a bond of some description to make it adhere: talc, soapstone, flour or molasses. For dry facing, talc is the best adulterant of plumbago, from 10 per cent. to 20 per cent. being the average admixture. The facing is applied to the surface of the mould in sufficient quantity to cover it lightly but evenly; it is then rubbed in by hand or camel's-hair brush, none of it being allowed to remain loose on the mould. This is the method adopted in greensand moulding; for drysand or core work it is necessary to mix with water, molasses, or liquid glue, and apply to the mould or core with a soft brush or swab.

When a smooth surface is desired to the castings, the moulds are smoothed over with a slick, after the facing has been put on. For heavy work, two or even three coats may be applied to insure the best results.

Lampblack or Return Facing. In making stove plate castings and other light work, which is very thin, an extremely smooth surface is required. Two facings are generally employed for this class of work. A first, or heavy facing, like graphite, to fill the pores of the sand; and a second or light facing, like lampblack, or any combination of lighter carbons, to make a good impression on the surface of the mould, and at the same time to prevent the first or heavy facing sticking to the pattern when it is *returned* to the mould, to assist in "peeling" the casting, and lastly to give it the proper colour.

Soot is peculiar to the foundry business, and the term "one of the black squad" is most appropriately applied to moulders. Some branches of moulding, such as "*face moulding*," or ornamental brass moulding, require a facing which will not clog the metal patterns, nor add materially to the weight of sharp impressions in fine chased work. Lampblack or ground carbon has been found to be the most suitable for this kind of work. It is also very well suited for general castings, but the sand does not peel so freely as when plumbago facing is used.

Flour. The best facing for brass-work in green-sand is undoubtedly pease-meal, but flour is almost as good, and can be had very much cheaper: the sweepings of the mill and the bakery are usually bought for this purpose. A common failure of the budding moulder is to use the flour-bag too freely, with the result that his castings are generally "flaked" on the top side. Flour is largely used by American foundrymen for mixing into core-sand.

Talc or the mineral **Steatite** is particularly suitable for the general purposes of the foundry facing, but more especially light castings and hollow-ware; it is granular, greasy, and comparatively incombustible. As a bond for the soft, friable plumbago, there is nothing to surpass it, and as a dry facing, for brass castings made in greensand, it is a very satisfactory substitute for the more expensive plumbago. This substance is known under different names, as "terra-flake," "white plumbago," *soapstone*, etc.

Sea-coal is called bituminous facing, but it is actually only a "*mixer.*" Sea-coal is mixed with moulding sand in proportions of from 1 to 10 or even 20, according to the size and weight of the casting to be made. Too much sea-coal used in the sand causes "*cold shut,*" streaked or "mapped" casting; not enough used will allow the sand to cling to the casting. Another advantage of sea-coal in facing sand is that it allows the gases to escape more freely than does ordinary sand by itself. The best qualities of sea-coal facing contain neither slate, sulphur, nor phosphorus, but are high in carbon and volatile matter.

Sands. Moulding sand requires to be mixed and tempered in various ways to suit different classes of work. The essential properties of a good moulding sand are the combination of adhesiveness and openness. These qualities are found in a suitable degree in some sands in their natural state, but as a rule, foundry sands have to be mixed—those of an argillaceous temperament with the siliceous grades—in order to produce good results. The moulder judges sand by the feel of it, and sometimes also by putting some in his hand and pressing it, he can tell by ear whether it is sharp enough for his purpose. The mixing of core-sands, facing-sands, *strong*-sands and loam is a great hobby with many moulders; but this is a study in which experience is the only guide, and as there are no standard mixtures or uniform sands, but only local qualities to work upon, it devolves upon the moulder to mix whatever grades he can get to his liking. We have seen cores made for very thin oil-boxes with moistened core-gum, with soft Belfast sand, and with hard rock sand, and in all cases the castings were a success; but, on the other hand, we have seen cores made for "chunky" castings with both Belfast and rock sands, and the castings were failures, as these sands alone were not able to stand the cutting action of the metal. Sands suitable for iron are not always suitable for brass. Brass is a more searching metal, and the sand used for moulding brass castings does not require to be quite so open as for iron. The sand for steel castings requires to stand a higher fire-test than any other moulding sand. A patent facing sand for steel castings consists of black sand 16 parts; white sand 4 parts; fireclay 1 part; chloride ammonia 1 part. The latter is dissolved in water and mixed in with the sands, the hot metal coming in contact with this facing decomposes the chloride and forms a gas which in its nascent state cleans the face of the casting. Another special sand for cores in steel foundries is composed of 2 bushels core-sand and 1 quart linseed oil.

Fluxes. Fluxes are useful to the founder only in so far as they have a refining influence on the metals he is using.

Many of the modern fluxes are supposed to have the additional virtue of imparting new properties to the metals; but it is only where metallic or semi-metallic bodies are used that this could be assured.

The standard flux for cast iron is limestone ; for steel, aluminium in some form; for brass, potash, nitre, or charcoal dust; for lead, tallow; for copper, silicon; for brazing-solder, borax ; for anti-friction alloys, sal-ammoniac.

Some founders pin their faith to one class of flux for refining purposes, and use quite a different article for regulating the properties of the metal. This is how it should be. Fluor-spar and carbide of silicon are both powerful fluxing agents in cast iron, but for ordinary mixtures excellent results can always be had with the good old stand-by—limestone. Again, "polled" copper is a vast improvement on the crude material, but nothing great in comparison with purified or partly alloyed copper.

Many experiments have been made in order to obtain *solid* copper castings with a high electrical efficiency. It is highly important that the conductivity shall be retained as near to that of pure copper as possible, and the metal that is highest in this respect will be most in demand for such castings as are required for electrical machines.

One of the most successful is gained by using Cowles' silicon, aluminium and copper alloy (pulverised) and manganese dioxide mixed in equal quantities. To two ounces of this add an equal quantity of a flux composed of borax and nitre equal parts ; this is sufficient to refine 100 lbs. of copper, and is added five minutes before pouring. A high degree of conductivity is claimed for this metal.

Boron is said to have much the same effect on copper as carbon has upon cast iron.

Oxide is one of the founder's greatest enemies, and fluxes are introduced into molten metals for the purpose of reducing or altering the oxides. The greater affinity a substance may possess for oxygen, the more likely is it to perform the function of a flux or de-oxidiser. No matter how carefully alloys may be melted they always contain a certain amount of oxide, and if a large quantity of it is present, the castings will be badly blown. Many of the so-called fluxes, therefore, are simply used as a protective covering, especially adapted for this purpose.

A mixture of this description is composed of borax, soda, alum and fluor-spar, each 1 part.

The following mixture for improving alloys, was also the subject of a patent: iron peroxide, 33 parts; manganese peroxide, 1 part; magnesium carbonate, ½ part; aluminium, 18 parts; silicon, 3½ parts; sodium biborate, 4 parts. Phosphorus and aluminium both act as reducing agents in combination with other metals, and they are especially active in lowering the fusion-point of metals. There is an important distinction between fluxes and reducing agents which is quite over-looked in the foundry. Fluxes yield slags, reducing agents yield metal. The action of reducing agents is the separation of the oxygen or sulphur from the metal with which it is combined, and owing to this fact they are sometimes called de-oxidising or de-sulphurising agents.

The principal de-oxidisers are: charcoal, borax, flour, tartar (i.e. potash and charcoal), fluor-spar, silicon and manganese. The addition of a flux is always advantageous: it cleans the metal, keeps it more fluid in the ladle, tends to set free occluded gases, and avoids blow-holes in the casting. Some of the metallic fluxes (so-called) have additional advantages, as aluminium in steel and iron, producing metal of superior ductility, toughness and softer skin for machining purposes, and taking away the tendency to chill at the edges or thinner parts of the castings; or bismuth in antifriction alloys in reducing friction; or manganese in copper, making it possible to cast this difficult metal satisfactorily.

Fuels. The fuels principally in use for melting metals are coke, coal, charcoal, oil and gas. In iron foundries solid fuel is a necessity; in steel foundries solid fuel is generally used, but gas is employed in some of the modern processes; in brass foundries, solid, liquid and gaseous fuels are all available for producing metal in a condition suitable for casting. Coke is the best fuel for melting iron in the cupola. It is strong and does not collapse while giving up its heat, therefore it is well adapted for bearing the burden of metal charged; it carries less impurities, which are detrimental to cast iron, than any other fuel.

Coke, high in fixed carbon and low in sulphur and ash, is desirable for melting iron. Cast iron absorbs about 4 per cent. of the sulphur in the coke, but rapid melting tends to lessen the proportion taken up; it follows then, that the quality of the coke and the amount needed to melt the charge both influence the quality of the castings and the expense of melting.

Coke is graded in two ways: 1st, by the manufacturers, according to the number of hours consumed in coking; 2nd, by the foundrymen, according to the number of pounds it weighs per bushel. Thus we have 24, 48 and 72 hour coke; also 32-lb. coke, 46-lb. coke, and up to 70-lb. coke. The longer coke remains (up to a certain period) in an oven in the process of coking, the denser and harder it becomes; also, the harder the coke, the longer the time required to consume it in a cupola, the heavier the burden it will carry and the larger the amount of iron it will melt. The following analyses of foundry cokes are within the specifications of a large foundry company in America:

	No. 1.	No. 2.
Moisture	0·33 per cent.	0·49 per cent.
Volatile matter ..	2·25 ,,	1·31 ,,
Fixed carbon ..	90·54 ,,	87·46 ,,
Sulphur	0·60 ,,	0·72 ,,
Ash	6·28 ,,	10·02 ,,
Structure, cellular	52·94 ,,	50·04 ,,
,, coke ..	47·06 ,,	49·96 ,,
Specific gravity ..	1·697	1·890

NOTE.—No. 1 is a light coke with medium porosity, and will give a quick intense heat. No. 2 is strong coke, more dense, and will give a steady continued heat and support a heavier burden of iron.

Gas is largely used as a fuel in the manufacture of steel, and in many instances the fuel is economised by the adoption of regenerating chambers, by pre-heating the blast, or by injecting steam. Gas furnaces are also a common feature in brass foundry practice. It is contended that gas is the most convenient form of fuel: it takes up little space, leaves no ash, and it can be controlled much easier than any of the solid fuels. Against these advantages we must put the drawbacks. The waste or melting loss of an expensive metal like brass is of primary importance to the brassfounder, and as that is increased by melting in gas furnaces, and the constituent metals are not so easily kept within required proportions, serious objections have been found in some quarters to gas as a fuel for melting brass. With oil as a fuel in crucible furnaces, air space is necessary to have proper combustion, and success depends on the regulation of the air supply for perfect combustion. Where too much air is admitted the waste of metal and crucibles is excessive; with too little air the metal is not delivered hot enough for casting. It is essential for the foundryman to understand the process of combustion and the effect on metals before he can get the best results from any fuel. Gases are absorbed by molten metal from the waste products of combustion and are locked up by the solidification of the metal, causing oxidation and forming blowholes. There is no uniformity in foundry melting methods, but it is generally conceded that coke gives the best results in cupola melting (unless we except the purest of all fuels, wood charcoal). Coal is well adapted for use in reverberatory furnaces, and gas-house charcoal is the most economical fuel for melting in crucibles.

NOTES ON METALS.

Cast Iron. Pig-iron, the product of the blast furnace, is crude cast iron. The term cast iron or foundry iron is always used to imply cupola iron. Elements *other* than iron in pig-iron regulate its character, and the composition of the iron put into the cupola regulates the physical properties and condition of the casting. There is a growing demand for pig-iron and castings of specified composition; and chemistry is now doing for the iron-founder what it has already done for the steel-maker. The custom of buying iron by fracture or grade number, is giving place to a great extent to the more accurate practice of selecting irons by chemical analyses. In many cases, too, foundry irons are being mixed by chemical formulæ. Since it has been realised that the contents of pig-iron is not revealed in "brand" or "grade," careful consumers have verified the analyses furnished by the seller, and mixed their iron according to the constituents present, or have rejected the irons as unfit for use, or have required an adjustment with the seller. Thus the average formula for light grey iron castings contains in the mixture, silicon, between 2·50 and 3·50 per cent.; carbon, 3 to 4 per cent.; phosphorus, 0·6 to 1·00 per cent.; sulphur, 0·05 to 0·080 per cent.; manganese about 0·50 per cent.

Formulæ for other castings is a matter of calculation: for example, stove-plate work would require maximum phosphorus, while heavy machinery would want minimum silicon.

Table of Chemical Composition of Light Castings (Iron).

—	(*A*) Mixture for Thin Castings under $\frac{3}{8}$ in. thickness.		(*B*) Mixture for Castings of an average thickness of $\frac{7}{8}$ in.		(*C*) Mixture for Castings $1\frac{1}{4}$ to 2 in. thick.	
	Limits Allowed.	Analyses Desired.	Limits Allowed.	Analyses Desired.	Limits Allowed.	Analyses Desired.
Silicon ..	2·45 to 2·65	2·55	2·30 to 2·50	2·40	2·15 to 2·35	2·25
Sulphur ..	0·07 to 0·10	0·08	0·07 to 0·10	0·09	0·08 to 0·12	0·10
Manganese	0·30 to 0·70	0·40	0·30 to 0·70	0·40	0·30 to 0·70	0·40
Phosphorus	0·70 to 1·00	0·90	0·50 to 0·90	0·70	0·40 to 0·80	0·60
Combined carbon	0·30 to 0·50	0·40	0·30 to 0·50	0·40	0·30 to 0·50	0·40
Graphite ..	2·90 to 3·20	3·10	2·90 to 3·20	3·10	2·90 to 3·20	3·00

For very heavy castings a mixture containing about 2·00 silicon should be used; other elements same as mixture (*C*)

General Remarks. The total carbon usually held by pig-iron is from 3·5 to 4·5 per cent. graphitic carbon predominating. Combined carbon adds strength to castings as well as hardness. The strongest castings are made from iron which will produce sound castings with the least amount of silicon ; about 0·20 per cent. of silicon is lost in re-melting. Silicon up to about 3·00 per cent. softens iron by keeping the carbon in the graphitic state ; 3·35 per cent. silicon in a casting, other conditions being equal, will produce maximum graphite. Soft iron will re-melt oftener than hard iron, but if a high breaking strain is required, silicon must necessarily be kept low.

Silicon is the element by which the founder makes hard or soft iron. The percentage necessary depends upon the amount of carbon present, and upon the balance of the composition. *Dr. Edward Kirk has characterised carbon as the true softener*, and hot blast charcoal iron as the best for general casting. Manganese produces hardness and shrinkage and also removes sulphur. Phosphorus reduces shrinkage, but should never exceed 1·00 per cent. High phosphorus irons are adapted to delicate patterns, because such iron is very limpid when molten ; the castings are very much weakened, other things being uniform. Sulphur increases fusibility of cast iron, but makes it sluggish when molten, giving rise to blowholes in castings. Sulphur should never exceed 0·10 per cent. Silicon, besides being a softener, if used in proper proportions, increases fluidity and fusibility. Lime or fluor-spar removes sulphur, and is the flux commonly used in the foundry. The average proportion of flux required is 7 to 10 lbs. lime to every ton of iron. Scrap in the mixture is regulated by two things, viz. whether it is "Home" or "Foreign" scrap, and whether it is mixed or selected. From 25 to 40 per cent. is a good average of scrap in ordinary mixtures. From 2 oz. to 5 oz. of aluminium to the ton of cast iron is said to produce soft iron by converting the combined carbon into graphite.

Steel. Historically, the advancement which has been made in the manufacture of steel, is a modern miracle. In the year 1856 Bessemer described his "converter" process of steel-making to the Members of the British Association assembled at Cheltenham. Following Bessemer were many who, stimulated by his success, introduced other processes of making steel, notably the regenerative process of Siemens. New discoveries have been made in the manufacture and treatment of steel, with such phenomenal strides, that it has been said we are now living in the Steel Age. Steel is a combination of iron and carbon, in which the proportion of carbon is very small. It occupies an intermediate position between cast iron and wrought iron, and it is produced by many different processes. In the foundry there are two prominent methods of producing steel employed in the manufacture of castings, viz. the crucible and the converter. Crucible cast steel was the invention of Benjamin Huntsman over 160 years ago, and is still recognised to be the most uniform in quality, and the hardest and most reliable steel for cutting tools. The tough quality of the so-called malleable iron castings which are made with special mixtures of iron in the cupola, depends altogether on the process of annealing. There is a great craze for alloyed steels, self-hardening steel, desulphurised steel, etc., but this does not affect the general foundry practice in making castings. It has been manifested by the introduction of alloyed steel that the metalloids contained in steel are confined to well-known limitations, while there is great latitude permissible in the amount of purely metallic elements introduced. To give an example: The so-called Taylor-White alloyed tool steel, with patent specifications, calls for carbon 1·85; chromium 2; tungsten 8·5; manganese 0·15; silicon 0·15; phosphorus 0·025; sulphur 0·03; and occasionally molybdenum is used. This leaves about 87 per cent. iron in the steel—a remarkably low proportion.

General Remarks. The *quality* of steel is regulated by the absence of phosphorus, sulphur and other impurities. The *grain* of steel is no indication of quality: hard steel shows a close fine grain, and a milder steel *of the same quality* shows a coarser grain. *Temper* means the percentage of carbon combined with the iron to produce steel. Carbon is the controlling element in steel.

Aluminium is probably the most abundant metal, but the difficulties of extracting the pure metal call for a comparatively high selling price. The early sodium reduction methods of obtaining aluminium have been completely superseded by electrolytic methods. As showing the progress that has been made in the manufacture of aluminium, in 1860 the price of an ounce, made by the Deville process, in France, was 7*s.* 6*d.*; to-day the cost is something like a penny. It is likely that aluminium will be more useful in combination with other metals, such as steel, magnesium, copper, silver or nickel, than as a simple metal. The ordinary aluminium of commerce is about 99 or 99·25 per cent. pure, the impurities being iron and silicon in about the following proportions: aluminium 99·25 per cent.; silicon 0·50 per cent.; iron 0·25 per cent.

In casting aluminium, pour the metal as *cold* and as *quickly* as possible. Use large sprues and cut heavy gates, unless on thin, delicate castings. Ram the moulds softly, use the swab sparingly and keep the sand as dry as practicable. Aluminium is not as liable to wash away portions of the mould as other metals on account of its lightness. Vent all moulds well.

Brass. Brass, and brassfounders' alloys have a very extensive and misleading nomenclature. It is generally conceded that the terms brass and bronze distinguish certain alloys of copper and zinc and copper and tin respectively. Nevertheless, numerous bronzes (so-called) are made without having any tin in their composition, and numerous brasses (so-called), as for example, the white anti-friction brasses, are made without zinc. In some districts like the Midlands, brass means a positive mixture of copper two parts and zinc one part; in others, as the Clyde or general marine districts, it means a common, cheap type of metal *having the colour of brass*, which is used for glands, gaurds and general mountings in marine engineering. The general public again characterise all metals having an approach to yellowness in colour under the general term of brass. There is a Standardising Bureau in the United States for determining the qualities of the different kinds of cast iron. Surely, when a simple and cheap metal like cast iron is treated as a technical compound, the vast array of expensive and complex alloys which are handled in the brass foundry, deserve no less consideration. The need for naming things correctly grows greater every day, as anyone actively engaged in industrial pursuits can testify. Many nostrums we know are sold under high-sounding names, and many imitations are passed off as being equal to and "chemically and mechanically" the same as genuine alloys of repute; so that, looking at the subject from almost any standpoint, it would be better for all concerned if some system of designating alloys could be devised, even although it was on the clumsy commercial basis which is sometimes made a means of identifying commodities. Thus, "the sixpence-halfpenny brass" and the ninepenny gun-metal would become familiar terms, but also a straight means of comparison would be presented to the unwary or unversed purchaser. The proper temperature at which the various brassfounders' alloys should be cast, is also a subject which deserves investigation. The best heat for good results is largely a matter of conjecture, and, in the foundry at least, altogether a question of practice. Heats in the sense of casting temperatures are only comparative in the foundry. Yellow brass might justly be said to be very hot, while gun-metal *at the same temperature* would be dull, and probably unfit for making castings. Many writers on alloys speak of the "proper heat" for casting; but no authority has yet ventured to fix the proper degree of heat for casting any of the alloys, and even if such a thing were done, there is the insuperable difficulty of the want of appliances for correctly determining the heat of metal in the foundry. The brassfounder uses a few terms and rules, which, again, are only comparative; for instance, he may express himself thus:—Yellow brass cannot be cast too hot; phosphor-bronze cannot be cast too dull; gun-metal should be cast at a "nice" heat, and antifriction-metal should never be allowed to come to a red heat. That is the whole foundry practice with regard to these metals in a few sentences. To say more would be to enlarge without enlightening the subject. This is really a matter for the attention of some body such as "The Alloys Research Committee," and one upon which it would be of untold benefit to the foundryman to have some definite pronouncement. As showing the amount of uncertainty which surrounds this question of the proper heat for casting alloys, we might add that we have seen one man judge the heat by the heat imparted to the skimmer in a given time; if the skimmer melted soon, then, if it was gun-metal or phosphor-bronze, the metal was too hot. Another man would judge the heat of the metal by the rate at which it was able to dissolve a "cooler," and yet another would depend on reflected light, and shut a window or a door for the purpose of seeing the metal in a dimmer atmosphere.

USEFUL MEMORANDA, RULES AND TABLES

Every foreman or foundry manager has a code of rules by which he estimates the weight of castings, the shrinkage of metals, or the pressure exerted on moulds by fluid metal. There are standard rules for all of these, but the foreman who is worth his salt knows that there are frequent exceptions, and takes especial care to "err on the safe side" (to use a common expression). Many thoroughly sound and practical rules, devised on this plan, have never been formulated, and indeed, many of them are of such a flexible nature that it would be a difficult matter to state them in cold, unsympathetic and unerring figures. Every man is justified in working by the rule which gives the greatest amount of satisfaction, no matter what its derivation may be. Thus in brass foundries, there is a rule regarding crucibles which is tacitly acknowledged by observant moulders, viz. that *all* the metal should be poured out, and none of it allowed to settle in the crucible. This is good practice, and where it is not observed there is a noticeable increase in the percentage of "running" pots, besides extra risk and loss. Another rule which is general in all foundries is to use core-boxes which are a "tight fit" for the prints. Rules for "feeding" or "slackening" castings, or weighting down boxes, are not so simple, and depend more often upon good judgment than upon any fixed equations or decisive theories. Figuring mixtures calls for a nice adjustment of different metals to bring about the various qualities and effects, and success depends altogether upon the founder having an accurate knowledge or estimate of the different grades. It is now recognised that mere mechanical tests or fractures are not sufficiently accurate for the best work, hence the reason of the new method of mixing irons by chemical analyses. A mechanical test may give an approximate idea of the strength, and with a knowledge of the shrinkage it may even give an inkling of the components—especially silicon—in cast iron, but it is at best an awkward test, as *the iron must first pass through the cupola* and be melted.

Circumference of a circle = diam. $\times$ 3·1416; or diam. $\times \frac{22}{7}$.

Area of a circle = diam.^{2} $\times$ ·7854; or radius^2 $\times$ 3·1416.

Area of an ellipse = the product of both diameters and ·7854.

Area of a triangle = the base multiplied by one-half of its height.

Side of an equal square = diam. × ·8862.

The side of a square × 1·414214 = the diameter of its circumscribing circle.

The surface of a sphere = $\text{diam.}^2 \times 3{\cdot}1416$.

The solidity of a sphere = $\text{diam.}^3 \times {\cdot}5236$.

Cubic inches		× ·00058	=	cubic ft., or cubic inches ÷ 1728 = cubic ft.
,,	,,	× ·26	=	lbs. cast iron.
,,	,,	× ·3	=	lbs. brass.
,,	,,	× ·32	=	lbs. copper.
,,	,,	× ·286	=	lbs. steel.
,,	,,	× ·41	=	lbs. lead.
,,	,,	× ·259	=	lbs. zinc.
,,	,,	× ·49	=	lbs. mercury.
,,	,,	× ·38	=	lbs. silver.
,,	,,	× ·7	=	lbs. gold.
,,	,,	× ·092	=	lbs. aluminium (pure).
,,	,,	× ·097	=	lbs. aluminium (commercial quality).
,,	,,	$\div 4 + \frac{1}{5}$	=	lbs. brass.
,,	,,	$\div 4 + \frac{1}{25}$	=	lbs. cast iron.

Lbs. avoirdupois		× ·009	=	cwts.
,,	,,	× ·00045	=	tons.
Tons	,,	× 2240	=	lbs.
Square inches		× ·007	=	sq. ft.

To find the weight of a cubic foot of substance, multiply its specific gravity by 62·4; the weight of a cubic inch = specific gravity × ·0361.

Rules for Converting Weight of Cast Iron into Brass.

The weight of cast iron × 1·16 = the weight in brass (approximate). Another rule: weight of cast iron $\times \frac{2}{13}$ gives the quotient to be added for brass.

Example. Find the weight of a plate 3 ft. sq. by $1\frac{1}{4}$ in. thick.

$$36 \times 36 \times 1{\cdot}25 = 1620 \text{ cubic inches.}$$

```
  1620 cubic inches                  1620 cubic inches
   ·26 (for iron)                      ·3 for brass
 ------                              ------
  9720                               486·0 lbs. weight in brass.
 3240                                =====
 ------
421·20 lbs. weight in cast iron
     2
 ------
13)842·40(64·80 + 421·20 = 486 lbs. = weight in brass.
   78
   ---
    62
    52
    ---
    104
    104
    ===
```

Rules to Find the Weight of Round Plates, Pipes, Pulley and Wheel Hems, etc.

Round Plates.

Rule 1.—Multiply half the circumference by half the diameter, multiply by the thickness of metal, and again by ·26 for cast iron or ·3 for brass = weight in lbs.

Rule 2.—Square the diameter of plate, multiply by ·7854 for area in square inches, multiply by thickness, and again by ·3 for brass or ·26 for cast iron.

Rule 3 (approximate).—Square diameter of plate, and multiply by thickness and again by ·2 for cast iron or ·24 for brass = weight in lbs.

Pipes, Pulley and Wheel Hems, etc.

Rule 1.—To the inner diameter add the thickness of metal, multiply by 3·1416 (or $3\frac{1}{7}$), and the product by the length of pipe; the result is the superficial area. Multiply the superficial area by the thickness to get cubic contents in inches, and again multiply by ·3 for brass or ·26 for cast iron for weight in lbs.

RULE 2.—Subtract the square of the inside diameter from the square of the outside, multiply by ·7854 for the superficial area, and again multiply by the length for cubic inches. Then multiply by ·3 for brass, or ·26 for cast iron = lbs.

RULE 3 (approximate).—Subtract the square of the inside diameter from the square of the outside diameter, and multiply by ·2 for cast iron or ·24 for brass; the result is the weight of one inch in length.

Example. Find the weight of a liner in brass 9 in. by 12 in. by ½ in. thick.

Rule 3.		Same Example compared by Rule 1, which is more accurate.
9 in. outside diam.,	8 in. inside diam.	8·5 inside diam.
9	8	$3\frac{1}{7}$
81	64	1·21
64		25·50
17		26·71 circumference
·24 for brass		12 length
68		320·52 area sq. in.
34		·5 thickness
4·08 lbs, weight of one inch		160·260 cubic in.
12		·3 for brass
48·96 lbs., weight of liner		48·0780 lbs. weight of liner

A Very Easy Method of Calculating the Weight of Metals of any Regular Section.

Note 1.—Always reduce any dimensions, as width, thickness, diameter, etc., to sixteenths of an inch.

Note 2.—Always square any sixteenths so found, as $1\frac{1}{4}$ inches = 20 × 20 sixteenths = 400 squared.

Note 3.—Always add to the square of the sixteenths the proportion given for each metal and each form of section.

Note 4.—Note that the result is always the weight in lbs. of 100 feet run, which can be instantly pointed off for 1 ft. as lbs. Thus:

432 = 100 feet run.
42·3 = 10 ,,
4·32 = 1 ,,

Square or Flat Sections.

Let lbs. per 100 feet run = sixteenths wide × sixteenths thick.

Add $\frac{1}{2}$	of the	squared	number for	copper.
,, $\frac{1}{3}$	,,	,,	,,	steel.
,, $\frac{22}{100}$	,,	,,	,,	cast iron.
,, $\frac{41}{100}$	,,	,,	,,	brass.

Example. Find the weight of a plate 3 feet square × $1\frac{1}{4}$ inch thick.

36 in. = 576 sixteenths.
$1\frac{1}{4}$ in. = 20 ,,
11520 ,, squared.
5760 add for copper $\frac{1}{2}$.
17280 lbs. 100 feet run.
3
518·40 lbs. 3 feet copper.

Usual Method.

36 side.
36 length.
216
108
1296
1·25 thickness.
6480
2592
1296
1620·00 cubic inches.
·32 for copper.
3240
4860
518·40 lbs. copper.

A plate of the same dimensions in cast iron would require $\frac{22}{100}$ to be added to the squared number, thus:

11520
22
23040
23040
÷ 100 = 2534·40
+ 11520
= 14054·40 lbs. per 100 ft. run.
3
421·6320 lbs. 3 ft. cast iron.

1620 cubic inches.
·26 for cast iron.
9720
3240
421·20 lbs. cast iron.

Round or Oval Sections.

Let lbs. 100 feet run = (diameter in sixteenths squared):

Add $\frac{1}{20}$ of the result for steel.
,, $\frac{1}{10}$,, ,, brass (castings).
,, $\frac{1}{6}$,, ,, copper ,,
Deduct $\frac{1}{20}$,, ,, cast iron.

Example. Find the weight of a solid column 12 inches by 10 feet long.

12 inches = 192 sixteenths.
192
384
1728
192
36864 sixteenths squared.
Add $\frac{1}{20}$ 1843·2
38707·2 lbs. weight in steel per 100 ft. [run.
3870·72 lbs. weight of 10 ft.

NOTE.—The weight of pipes or liners can be got in this way by "taking out" the weight of two cylindrical solids, one for the outside diameter and one for the core, and subtracting.

For the sake of comparison we work out the above example by the usual method of finding the cubic inches × ·3 for brass. Thus:

Usual Method.

12 in. diam.
12
144
·7854
576
720
1152
1008
113·0976 area sq. in.
120 inches in length.
13571·7120 cubic inches.
·3 for brass.
4071·51360 lbs.

Sixteenths × Sixteenths Method.

12 in. = 192 sixteenths.
192
384
1728
192
36864 diam. in sixteenths squared.
3686·4 $\frac{1}{10}$ added for brass.
40550·4 lbs. 100 ft. run.
4055·04 lbs. 10 ft.

This shows a difference of 16 lbs., which is a mere trifle in the matter of 36 cwts.

Weight of Spur-Wheel Castings (Cast Iron).

$$W = \frac{P^2 \times N \times B}{C},$$

where P = pitch in inches; N = number of teeth; B = breadth in inches; W = weight in cwt.; C = constant, which up to 2-in. pitch = 270; from 2 in. to 3-in. = 250; from 3-in. to 4-in. = 245.

Approximate Rules for Finding the Weight of Wheels.

Rule 1.—Multiply the number of teeth by the square of the pitch, and by the breadth of face, and by ·4 for the weight in lbs. cast iron.

Rule 2.—Calculate the weight of wheel hem (as in example for pipes, etc.), double this weight, and multiply by 2·2 for the weight of whole wheel in lbs. cast iron.

Rule for Weighting Down Moulds before Casting.

"The number of square feet in the surface of mould multiplied by the height of flow-gates above the surface, and by 40 as a constant, gives the weight required to resist the strain in lbs. avoirdupois."—*Neave.*

Table of Constant Numbers for Finding the Lengths of Chords for Dividing Circles.

Rule.—Multiply the constant in the Table to the right of that figure which represents the number of parts into which you wish the circle divided by the diameter of the circle in inches, and the product will be the length of chord required *in inches.*

Example. It is required to divide a 60-inch circle into 11 equal parts.

·281901 = the constant for 11 parts.*
60 = the diam. of the circle in inches.
16·914060 = $16\frac{59}{64}$ bare inches = length of chord required.

Note.—For decimal equivalents of fractional parts of an inch, see p. 197.

* Example marked in Table.

Table of Constants.

No. of Parts.	Constant.	No. of Parts.	Constant.	No. of Parts.	Constant.
3	·86588516	15	·207916	27	·11588375
4	·70703125	16	·1953125	28	·11197916
5	·58724	17	·18359375	29	·10807291
6	·5	18	·1735025	30	·1045833
7	·43359375	19	·1640625	31	·10091145
8	·3828125	20	·156667	32	·09765625
9	·3418	21	·14908854	33	·09472656
10	·308177	22	·1422526	34	·09210573
11	·281901*	23	·1360677	35	·08951823
12	·25846354	24	·13020833	36	·08724
13	·239166	25	·125		
14	·222	26	·12044270		

Table for Converting Ounces into Decimal Parts of a Pound.

Ounces.	Decimal Equivalents.	Ounces.	Decimal Equivalents.	Ounces.	Decimal Equivalents.
1	·06	6	·37	11	·69
1½	·09	6½	·40	11½	·72
2	·12	7	·43	12	·75
2½	·15	7½	·46	12½	·78
3	·19	8	·50	13	·81
3½	·22	8½	·53	13½	·84
4	·25	9	·56	14	·87
4½	·28	9½	·59	14½	·90
5	·31	10	·62	15	·94
5½	·34	10½	·65	15½	·97

Rule for the Weight of Pipes.

D = outside diameter of pipe in inches.
d = inside diameter.
w = weight of a lineal foot of pipe in lbs.
$W = K(D^2 - d^2)$.
K = 2·45 for cast iron.
= 2·64 for wrought iron.
= 2·82 for brass.
= 3·03 for copper.
= 3·87 for lead.

Shrinkage of Castings.

The usual allowance for each foot in length is as follows:—

	in.		in.
In large cylinders . . =	$\frac{3}{32}$	In tin . . . . =	$\frac{1}{4}$
,, small ,, . . =	$\frac{1}{16}$	,, copper . . . . . . =	$\frac{3}{16}$
,, beams and girders . =	$\frac{1}{10}$	,, bismuth . . . . . =	$\frac{5}{32}$
,, thick brass . . . =	$\frac{5}{32}$	,, cast-iron pipes . . =	$\frac{1}{8}$
,, thin ,, . . . =	$\frac{1}{8}$	,, aluminium . . . =	$\frac{17}{64}$
,, zinc . . . . . . =	$\frac{5}{16}$	,, Delta metal . . . =	$\frac{3}{16}$
,, lead . . . . . . =	$\frac{5}{16}$	,, gun-metal (in 9 in.) . =	$\frac{1}{8}$

Bauer's Drill Test for Hardness of Metals.*

(*Average of* 100 *tests with each metal.*)

Showing the revolutions required in boring exactly $\frac{1}{2}$ inch of metal, using a $\frac{3}{3}$ inch twist drill, the pressure on the drill being 160 lbs., and running at 350 revolutions per minute.

Metals.	Revs.	Metals.	Revs.
Lead (pig)	7	Zinc	70
Pewter	8	Aluminium	89
"A" Babbitt	11	Antimony	106
"B" ,, ...	12	Copper (ingot)	160
Antimony lead	12	Phosphor-bronze (white) .	164
Stereotype metal	12	Hard bronze (88·12) . .	244
Tin (block)	13	Phosphor-bronze (red) . .	253
Tin (5 per cent. phosphorus)	13	Wrought iron . . .	400–600
"C" Babbitt (hard) . .	18	Cast iron	200–700

* *The Foundry*, August 1901.

Rules for Converting Prices *per ton, cwt. and lb. into prices per lb., cwt. and ton, and vice versa.*

Rule 1.—At any price per lb., to find shillings per cwt. or £ per ton, multiply the price in pence per lb. by $\frac{28}{3}$.

Rule 2.—At any £ per ton, or shillings per cwt., to find the price per lb., multiply £ per ton or shillings per cwt. by $\frac{3}{28}$.

Decimal Equivalents of Fractional Parts of an Inch.

Fractions.	Decimals.	Fractions.	Decimals.	Fractions.	Decimals.	Fractions.	Decimals.
$\frac{1}{64}$	0·015625	$\frac{17}{64}$	0·265625	$\frac{33}{64}$	0·515625	$\frac{49}{64}$	0·765625
$\frac{1}{32}$	0·03125	$\frac{9}{32}$	0·28125	$\frac{17}{32}$	0·53125	$\frac{25}{32}$	0·78125
$\frac{3}{64}$	0·046875	$\frac{19}{64}$	0·296875	$\frac{35}{64}$	0·546875	$\frac{51}{64}$	0·796875
$\frac{1}{16}$	0·0625	$\frac{5}{16}$	0·3125	$\frac{9}{16}$	0·5625	$\frac{13}{16}$	0·8125
$\frac{5}{64}$	0·078125	$\frac{21}{64}$	0·328125	$\frac{37}{64}$	0·578125	$\frac{53}{64}$	0·828125
$\frac{3}{32}$	0·09375	$\frac{11}{32}$	0·34375	$\frac{19}{32}$	0·59375	$\frac{27}{32}$	0·84375
$\frac{7}{64}$	0·109375	$\frac{23}{64}$	0·359375	$\frac{39}{64}$	0·609375	$\frac{55}{64}$	0·859375
$\frac{1}{8}$	0·125	$\frac{3}{8}$	0·375	$\frac{5}{8}$	0·625	$\frac{7}{8}$	0·875
$\frac{9}{64}$	0·140625	$\frac{25}{64}$	0·390625	$\frac{41}{64}$	0·640625	$\frac{57}{65}$	0·890625
$\frac{5}{32}$	0·15625	$\frac{13}{32}$	0·40625	$\frac{21}{32}$	0·65625	$\frac{29}{32}$	0·90625
$\frac{11}{64}$	0·171875	$\frac{27}{64}$	0·421865	$\frac{43}{64}$	0·671875	$\frac{59}{64}$	0·921875*
$\frac{3}{16}$	0·1875	$\frac{7}{16}$	0·4375	$\frac{11}{16}$	0·6875	$\frac{15}{16}$	0·9375
$\frac{13}{64}$	0·203125	$\frac{29}{64}$	0·453125	$\frac{45}{64}$	0·703125	$\frac{61}{64}$	0·953125
$\frac{7}{32}$	0·21875	$\frac{15}{32}$	0·46875	$\frac{23}{32}$	0·71875	$\frac{31}{32}$	0·96875
$\frac{15}{64}$	0·234375	$\frac{31}{64}$	0·484375	$\frac{47}{64}$	0·734375	$\frac{63}{64}$	0·984375
$\frac{1}{4}$	0·25	$\frac{1}{2}$	0·5	$\frac{3}{4}$	0·75	1	1·0

Weight of a Square Foot of Metals.

Thickness advancing by sixteenths of an inch.

Thickness.	Wrought Iron. Specific Weight =1.	Cast Iron. Specific Weight =·9375.	Copper. Specific Weight =1·16.	Tin. Specific Weight =·962.	Brass. Specific Weight =1·052.	Gun-metal. Specific Weight =1·092.	Lead. Specific Weight =1·48.	Zinc. Specific Weight =·910.
in.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
1/16	2·50	2·34	2·89	2·41	2·63	2·73	3·71	2·28
1/8	5·00	4·69	5·79	4·81	5·26	5·46	7·41	4·55
3/16	7·50	7·03	8·68	7·22	7·89	8·19	11·1	6·83
1/4	10·0	9·38	11·6	9·63	10·5	10·9	14·8	9·10
5/16	12·5	11·7	14·5	12·0	13·2	13·7	18·5	11·4
3/8	15·0	14·1	17·4	14·4	15·8	16·4	22·5	13·7
7/16	17·5	16·4	20·3	16·8	18·4	19·1	25·9	15·9
1/2	20·0	18·7	23·2	19·3	21·1	21·9	29·7	18·2
9/16	22·5	21·1	26·0	21·7	23·7	24·6	33·4	20·5
5/8	25·0	23·5	28·9	24·1	26·3	27·3	37·1	22·8
11/16	27·5	25·8	31·8	26·5	28·9	30·0	40·8	25·0
3/4	30·0	28·1	34·7	28·9	31·6	32·8	44·5	27·3
13/16	32·5	30·5	37·6	31·3	34·2	35·0	48·2	29·6
7/8	35·0	32·8	40·5	33·7	36·8	38·2	51·9	31·9
15/16	37·5	35·2	43·4	36·1	39·5	41·0	55·6	34·1
1	40·0	37·5	46·3	38·5	42·1	43·7	59·3	36·4

Weight of Metals of a given Sectional Area per Lineal Foot and per Lineal Yard.

Sectional Area.	Rolled Wrought Iron. Specific Weight = 1.		Cast Iron. Specific Weight = 0·9375.		Steel. Specific Weight = 1·02.		Brass. Specific Weight = 1·052.		Gun-Metal. Specific Weight = 1·092.	
	1 ft.	1 yd.	1 ft.	1 yd.	1 ft.	1 yd.	1 ft.	1 yd.	1 ft.	1 yd.
sq. in.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.	lb.
0·1	0·333	1·0	0·313	0·938	0·340	1·02	0·351	1·05	0·364	1·09
0·5	1·67	5·0	1·56	4·69	1·70	5·10	1·75	5·26	1·82	5·46
1·0	3·33	10·0	3·15	9·38	3·40	10·2	3·51	10·5	3·64	10·9
1·5	5·00	15·0	4·69	14·1	5·10	15·3	5·26	15·8	5·46	16·4
2·0	6·67	20·0	6·25	18·8	6·80	20·4	7·01	21·0	7·28	21 8
3·0	10·0	30·0	9·38	28·1	10·2	30·6	10·5	31·6	10·9	32·8
4·0	13·3	40·0	12·5	37·5	13·6	40·8	14·0	42·1	14·6	43·7
5·0	16·7	50·0	15·6	46·9	17·0	51·0	17·5	52·6	18·2	54·6
6·0	20·0	60·0	18·8	56·3	20·4	61·2	21·0	63·1	21·8	65·5
7·0	23·3	70·0	21·9	65·6	23·8	71·4	24·6	73·6	25·5	76·4
8·0	26·7	80·0	25·0	75·0	27·2	81·6	28·1	84·2	29·1	87·4
9·0	30·0	90·0	28·1	84·4	30·6	91·8	31·6	94·7	32·8	98·3
10·0	33·3	100·0	31·3	93·8	34·0	102·0	35·1	105·2	36·4	109·2

TABLE OF WEIGHT OF CAST IRON.

Thickness or Diameter in Inches.	Thickness or Diameter in Decimals of a Foot.	Weight of a Square Foot.	Weight of a Square Bar 1 ft. long.	Weight of a Round Bar 1 ft. long.	Weight of Balls.	Thickness or Diameter in Inches.	Thickness or Diameter in Decimals of a Foot.	Weight of a Square Foot.	Weight of a Square Bar 1 ft. long.	Weight of a Round Bar 1 ft. long.	Weight of Balls.
		lb.	lb.	lb.	lb.			lb.	lb.	lb.	lb.
$\frac{1}{32}$	·0026	1·173	0·003	0·002		$3\frac{1}{8}$	·2604	117·3	30·52	23·97	4·162
$\frac{1}{16}$	·0052	2·344	0·012	0·010		$\frac{1}{4}$	·2708	121·8	33·01	25·93	4·681
$\frac{3}{32}$	·0078	3·516	0·027	0·021	0·0001	$\frac{3}{8}$	·2813	126·5	35·60	27·95	5·243
$\frac{1}{8}$	·0104	4·687	0·048	0·038	0·0003	$\frac{1}{2}$	·2917	131·2	38·28	30·07	5·846
$\frac{5}{32}$	·0130	5·861	0·076	0·060	0·0005	$\frac{5}{8}$	·3021	135·9	41·07	32·25	6·498
$\frac{3}{16}$	·0156	7·032	0·110	0·086	0·0009	$\frac{3}{4}$	·3125	140·6	43·95	34·51	7·193
$\frac{7}{32}$	·0182	8·203	0·150	0·118	0·0014	$\frac{7}{8}$	·3229	145·3	46·93	36·85	7·934
$\frac{1}{4}$	·0208	9·375	0·195	0·154	0·0021	4	·3333	150·0	50·01	39·27	8·726
$\frac{9}{32}$	·0234	10·54	0·247	0·194	0·0030	$\frac{1}{8}$	·3438	154·7	53·18	41·77	9·572
$\frac{5}{16}$	·0260	11·73	0·305	0·240	0·0042	$\frac{1}{4}$	·3542	159·3	56·46	44·33	10·47
$\frac{11}{32}$	·0287	12·89	0·370	0·290	0·0056	$\frac{3}{8}$	·3646	164·0	59·82	46·99	11·42
$\frac{3}{8}$	·0313	14·06	0·440	0·346	0·0072	$\frac{1}{2}$	·3750	168·7	63·33	49·71	12·43
$\frac{13}{32}$	·0339	15·24	0·516	0·400	0·0092	$\frac{5}{8}$	·3854	173·4	66·86	52·52	13·49
$\frac{7}{16}$	·0365	16·41	0·598	0·470	0·0114	$\frac{3}{4}$	·3958	178·1	70·52	55·39	14·62
$\frac{15}{32}$	·0391	17·56	0·687	0·540	0·0140	$\frac{7}{8}$	·4063	182·8	74·28	58·34	15·81
$\frac{1}{2}$	·0417	18·75	0·781	0·610	0·0170	5	·4167	187·5	78·12	61·37	17·05
$\frac{9}{16}$	·0469	21·10	0·989	0·777	0·0243	$\frac{1}{8}$	·4271	192·2	82·10	64·47	18·35
$\frac{5}{8}$	·0521	23·44	1·221	0·959	0·0334	$\frac{1}{4}$	·4375	196·9	86·14	67·65	19·73
$\frac{11}{16}$	·0573	25·79	1·478	1·161	0·0444	$\frac{3}{8}$	·4479	201·6	90·29	70·52	21·18
$\frac{3}{4}$	·0625	28·12	1·758	1·381	0·0575	$\frac{1}{2}$	·4583	206·2	94·54	74·26	22·68
$\frac{13}{16}$	·0677	30·47	2·064	1·621	0·0732	$\frac{5}{8}$	·4688	210·9	98·89	77·66	24·27

7/8	·0729	32·81	2·393	1·880	0·0913	3/4	·4792	215·6	103·3	81·16	25·93
15/16	·0781	35·16	2·747	2·158	0·1124	7/8	·4896	220·3	107·9	84·72	27·41
1	·0833	37·50	3·125	2·455	0·1363	6	·5000	225·0	112·5	88·30	29·44
1/16	·0885	39·84	3·528	2·771	0·1636	1/4	·5208	234·4	122·1	95·89	33·28
1/8	·0938	42·19	3·955	3·107	0·1942	1/2	·5417	243·8	132·0	103·7	37·44
3/16	·0990	44·53	4·407	3·461	0·2284	3/4	·5625	253·1	142·4	111·9	41·94
1/4	·1042	46·87	4·883	3·835	0·2661	7	·5833	262·5	153·2	120·2	46·77
5/16	·1094	49·22	5·384	4·229	0·3084	1/4	·6042	271·9	164·2	129·0	51·97
3/8	·1146	51·57	5·969	4·640	0·3546	1/2	·6250	281·3	175·8	138·1	57·54
7/16	·1198	53·91	6·461	5·073	0·4058	3/4	·6458	290·7	187·7	147·4	63·47
1/2	·1250	56·26	7·033	5·523	0·4603	8	·6667	300·0	200·1	157·0	69·82
9/16	·1302	58·60	7·632	5·993	0·5204	1/4	·6875	309·4	212·7	167·0	76·58
5/8	·1354	60·94	8·253	6·484	0·5852	1/2	·7083	318·8	225·8	177·3	83·74
11/16	·1406	63·28	8·900	6·991	0·6555	3/4	·7292	328·2	239·3	187·9	91·35
3/4	·1458	65·63	9·572	7·518	0·7310	9	·7500	337·4	253·1	198·8	99·42
13/16	·1510	57·97	10·27	8·064	0·8122	1/4	·7708	346·8	267·4	210·0	107·9
7/8	·1563	70·32	10·99	8·630	0·8991	1/2	·7917	356·2	282·1	221·5	116·8
15/16	·1615	72·66	11·73	9·215	0·9920	3/4	·8125	365·6	297·0	233·3	126·3
2	·1667	75·01	12·50	9·821	1·073	10	·8333	375·0	312·5	245·5	136·3
1/8	·1771	79·70	14·11	11·09	1·308	1/4	·8542	384·4	328·4	257·8	146·8
1/4	·1875	84·40	15·83	12·43	1·554	1/2	·8750	393·7	344·5	270·6	157·9
3/8	·1979	89·07	17·63	13·85	1·827	3/4	·8958	403·1	361·2	283·7	169·3
1/2	·2083	93·75	19·54	15·34	2·131	11	·9167	412·5	378·2	297·0	181·5
5/8	·2188	98·44	21·54	16·56	2·467	1/4	·9375	421·9	395·5	310·6	194·2
3/4	·2292	103·2	23·64	18·56	2·835	1/2	·9583	431·2	413·3	324·6	207·3
7/8	·2396	107·8	25·84	20·29	3·241	3/4	·9792	440·6	431·4	338·8	219·2
3	·2500	112·6	28·13	22·10	3·682	12	1 ft.	450·0	450·0	353·4	235·6

Weight of Cast-Iron Pipe per foot in pounds.

These weights are for plain pipe. For hautboy pipe add 8 inches in length for each joint. For copper, add $\frac{1}{5}$; for lead, $\frac{3}{8}$; for welded iron, add $\frac{1}{15}$, or multiply by 1·0667.

Diameter of Bore. in.	Thickness of Pipe in inches.									
	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1	$1\frac{1}{8}$	$1\frac{1}{4}$	$1\frac{3}{8}$
1	3·07	5·07	7·38	..	..	..	..	..	..	..
$1\frac{1}{4}$	3·69	6·00	8·61	..	..	..	..	..	..	..
$1\frac{1}{2}$	4·30	6·92	9·84	..	..	..	..	..	..	..
$1\frac{3}{4}$	4·92	7·84	11·10	..	..	..	..	..	..	..
2	5·53	8·76	12·30	16·2	..	..	..	..	..	..
$2\frac{1}{4}$	6·15	9·69	13·50	17·7	..	..	..	..	..	..
$2\frac{1}{2}$	6·76	10·60	14·80	19·2	24·0	..	..	..	..	..
$2\frac{3}{4}$	7·37	11·50	16·00	20·8	25·9	..	..	..	..	..
3	7·98	12·50	17·20	22·3	27·7	33·4	..	..	..	..
$3\frac{1}{2}$	9·21	14·30	19·70	25·4	31·4	37·7	..	..	..	..
4	10·30	16·10	22·20	28·5	35·1	42·0	..	..	..	..
$4\frac{1}{2}$	11·70	18·00	24·60	31·5	38·8	46·3	..	..	..	..
5	12·90	19·80	27·10	34·6	42·5	50·6	..	..	..	..
$5\frac{1}{2}$	14·20	21·70	29·50	37·7	46·1	54·9	..	..	..	..
6	15·40	23·50	32·00	40·8	49·8	59·2	68·9	..	..	..
$6\frac{1}{2}$	16·60	25·40	34·50	43·8	53·5	63·5	73·8	84·4	..	..

7	17·80	27·20	36·90	46·9	57·2	67·8	78·7	89·4	..	..
7½	19·10	29·10	39·40	50·0	60·9	72·1	83·7	95·5	108	..
8	20·30	30·90	41·80	53·1	64·6	76·4	88·6	101·0	114	127
8½	21·50	32·80	44·30	56·1	68·3	80·7	93·5	107·0	120	134
9	22·80	34·60	46·80	59·2	72·0	85·1	98·4	112·0	126	140
9½	24·00	36·40	49·20	62·3	75·7	89·3	103·0	118 0	132	147
10	25·10	38·30	51·70	65·3	79 4	93·6	108·0	123·0	138	164
11	27·60	42·00	56·60	71·5	86·7	102·0	118·0	134·0	151	168
12	30·00	45·70	61·50	77·7	94·1	111·0	128·0	145·0	163	181
13	32·50	49·40	66·40	83·8	102·0	120·0	138·0	156·0	175	195
14	35·00	53·10	71·40	89·4	109·0	128·0	148·0	168·0	188	208
15	37·40	56·70	76·30	96·1	116·0	137·0	158·0	179·0	200	222
16	39·10	60·40	81·20	102·0	124·0	145·0	167·0	190·0	212	235
17	42·30	64·10	86·10	108·0	131·0	154·0	177·0	201·0	225	249
18	44·80	67·80	91·00	115·0	139·0	163·0	187·0	212·0	237	262
19	47·30	71·50	96·00	121 0	146·0	171·0	197·0	223·0	249	276
20	49·70	75·20	101·00	127·0	153·0	180·0	207·0	234·0	261	289
22	54·60	82·60	111·00	139·0	168·0	196·0	227·0	256·0	286	316
24	59·60	89·90	121·00	152·0	183·0	214·0	246·0	278·0	311	343
26	64·50	97·30	131·00	164·0	198·0	231·0	266·0	300·0	335	370
28	69·40	105·00	140·00	176·0	212·0	249·0	286·0	323·0	360	397
30	74·20	112·00	150·00	188·0	227·0	266·0	305·0	345·0	384	424

TABLE OF THE CIRCUMFERENCES AND

Diamr.	0		1/8		1/4		3/8	
	Circm.	Area.	Circm.	Area.	Circm.	Area.	Circm.	Area.
0	—	—	·3927	·0123	·7854	·0491	1·178	·1104
1	3·142	·7854	3·534	·9940	3·927	1·227	4·320	1·485
2	6·283	3·142	6·676	3·547	7·069	3·976	7·461	4·430
3	9·425	7·069	9·818	7·670	10·21	8·296	10·60	8·946
4	12·57	12·57	12·96	13·36	13·35	14·19	13·74	15·03
5	15·71	19·64	16·10	20·63	16·49	21·65	16·89	22·69
6	18·85	28·27	19·24	29·46	19·64	30·68	20·03	31·92
7	21·99	38·48	22·38	39·87	22·78	41·28	23·17	42·72
8	25·13	50·27	25·53	51·85	25·92	53·46	26·31	55·09
9	28·27	63·62	28·67	65·40	29·06	67·20	27·45	69·03
10	31·42	78·54	31·81	80·52	32·20	82·52	32·59	84·54
11	34·56	95·03	34·95	97·21	35·34	99·40	37·74	101·6
12	37·70	113·1	38·09	115·5	38·48	117·9	38·88	120·3
13	40·84	132·7	41·23	135·3	41·63	137·9	42·02	140·5
14	43·98	153·9	44·38	156·7	44·77	159·5	45·16	162·3
15	47·12	176·7	47·52	179·7	47·91	182·7	48·30	185·7
16	50·27	201·1	50·66	204·2	51·05	207·4	51·44	210·6
17	53·41	227·0	53·80	230·3	54·19	233·7	54·59	237·1
18	56·55	254·5	56·94	258·0	57·33	261·6	57·73	265·2
19	59·69	283·5	60·08	287·3	60·48	291·1	60·87	294·8
20	62·83	314·2	63·22	318·1	63·62	322·1	64·01	326·1
21	65·97	346·4	66·37	350·5	66·76	354·7	67·15	358·8
22	69·12	380·1	69·51	384·5	69·90	388·8	70·29	393·2
23	72·26	415·5	72·65	420·0	73·04	424·6	73·43	429·1
24	75·40	452·4	75·79	457·1	76·18	461·9	76·58	466·6
25	78·54	490·9	78·93	495·8	79·33	500·7	79·72	505·7
Diamr.	Circm.	Area.	Circm.	Area.	Circm.	Area	Circm.	Area.
	0		1/8		1/4		3/8	

Areas of Circles, Advancing by Eighths.

½		⅝		¾		⅞		Diamr.
Circm.	Area.	Circm.	Area.	Circm.	Area.	Circm.	Area.	
1·571	·1963	1·964	·3068	2·356	·4418	2·749	·6013	0
4·712	1·767	5·105	2·074	5·498	2·405	5·891	2·761	1
7·854	4·909	8·247	5·412	8·639	5·940	9·032	6·492	2
11·00	9·621	11·39	10·32	11·78	11·04	12·17	11·79	3
14·14	15·90	14·53	16·80	14·92	17·72	15·32	18·67	4
17·28	23·76	17·67	24·85	18·06	25·97	18·46	27·11	5
20·42	33·18	20·81	34·47	21·21	35·78	21·60	37·12	6
23·56	44·18	23·95	45·66	24·35	47·17	24·74	48·71	7
26·70	56·75	27·10	58·43	27·49	60·13	27·88	61·86	8
29·85	70·88	30·24	72·76	30·63	74·66	31·02	76·59	9
32·99	86·59	33·38	88·66	33·77	90·76	34·16	92·89	10
36·13	103·9	36·52	106·1	36·91	108·4	37·31	110·8	11
39·27	122·7	39·67	125·2	40·06	127·7	40·45	130·2	12
42·41	143·1	42·80	145·8	43·20	148·5	43·59	151·2	13
45·55	165·1	45·95	168·0	46·34	170·9	46·73	173·8	14
48·69	188·7	49·09	191·7	49·48	194·8	49·87	197·9	15
51·84	213·8	52·23	217·1	52·62	220·4	53·01	223·7	16
54·98	240·5	55·37	244·0	55·76	247·4	56·16	250·9	17
58·12	268·8	58·51	272·4	58·90	276·1	59·30	279·8	18
61·26	298·6	61·65	302·5	62·05	306·4	62·44	310·2	19
64·40	330·1	64·80	334·1	65·19	338·2	65·58	342·3	20
67·54	363·1	67·94	367·3	68·33	371·5	68·72	375·8	21
70·69	397·6	71·08	402·0	71·47	406·5	71·86	411·0	22
73·83	433·7	74·22	438·4	74·61	443·0	75·01	447·7	23
76·97	471·4	77·36	476·3	77·75	481·1	78·15	486·0	24
80·11	510·7	80·50	515·7	80·90	520·8	81·29	525·8	25
Circm.	Area.	Circm.	Area.	Circm.	Area.	Circm.	Area.	Diamr.
½		⅝		¾		⅞		

SQUARES AND CUBES (FRACTIONAL).

No.	Square.	Cube.	No.	Square.	Cube.
1	1·0000	1·0000	7	49·0000	343·0000
1⅛	1·2656	1·4238	7⅛	50·7656	361·7050
1¼	1·5625	1·9531	7¼	52·5625	381·0781
1⅜	1·8906	2·5996	7⅜	54·3906	401·1308
1½	2·2500	3·3750	7½	56·2500	421·8750
1⅝	2·6406	4·2910	7⅝	58·1406	443·3222
1¾	3·0625	5·3593	7¾	60·0625	465·4843
1⅞	3·5156	6·5917	7⅞	62·0156	488·3730
2	4·0000	8·0000	8	64·0000	512·0000
2⅛	4·5156	9·5957	8⅛	66·0156	536·3769
2¼	5·0625	11·3906	8¼	68·0625	561·5156
2⅜	5·6406	13·3964	8⅜	70·1406	587·4277
2½	6·2500	15·6250	8½	72·2500	614·1250
2⅝	6·8906	18·0879	8⅝	74·3906	641·6191
2¾	7·5625	20·7968	8¾	76·5625	669·9218
2⅞	8·2656	23·7536	8⅞	78·7656	699·0449
3	9·0000	27·0000	9	81·0000	729·0000
3⅛	9·7656	30·5175	9⅛	83·2656	759·7988
3¼	10·5625	34·3281	9¼	85·5625	791·4531
3⅜	11·3906	38·4432	9⅜	87·8906	823·9743
3½	12·2500	42·8760	9½	90·2500	857·3750
3⅝	13·1406	47·6346	9⅝	92·6406	891·6660
3¾	14·0625	52·7343	9¾	95·0625	926·8593
3⅞	15·0156	58·1854	9⅞	97·5156	962·9668
4	16·0000	64·0000	10	100·0000	1000·0000
4⅛	17·0155	70·1893	10⅛	102·5156	1037·9707
4¼	18·0625	76·7656	10¼	105·0625	1076·8906
4⅜	19·1406	83·7401	10⅜	107·6406	1116·7714
4½	20·2500	91·1250	10½	110·2500	1157·6250
4⅝	21·3906	98·9315	10⅝	112·8906	1199·4628
4¾	22·5625	107·1718	10¾	115·5625	1242·2968
4⅞	23·7656	115·8573	10⅞	118·2656	1286·1386
5	25·0000	125·0000	11	121·0000	1331·0000
5⅛	26·2656	134·6112	11⅛	123·7656	1376·8925
5¼	27·5625	144·7031	11¼	126·5625	1423·8281
5⅜	28·8906	155·2869	11⅜	129·3906	1471·8183
5½	30·2500	166·3750	11½	132·2500	1520·8750
5⅝	31·6406	177·9783	11⅝	135·1406	1571·0097
5¾	33·0625	190·1093	11¾	138·0625	1622·2343
5⅞	34·5156	202·7791	11⅞	141·0156	1674·5605
6	36·0000	216·0000	12	144·0000	1728·0000
6⅛	37·5156	229·7332	12⅛	147·0156	1782·5644
6¼	39·0625	244·1406	12¼	150·0625	1838·2656
6⅜	40·6406	259·0839	12⅜	153·1406	1895·1152
6½	42·2500	274·6250	12½	156·2500	1953·1250
6⅝	43·8906	290·7754	12⅝	159·3906	2012·3066
6¾	45·5625	307·5468	12¾	162·5625	2072·6718
6⅞	47·2656	324·9511			

Comparative Weights of Different Metals.

—	Wrought Iron.	Cast Iron.	Copper	Brass.	Gun-metal.	Lead.	Zinc.
Wrought Iron	1·0	·954	1·151	1·1	1·15	1·5	·942
Cast Iron .	1·04	1·0	1·213	1·154	1·208	1·564	·988
Copper . .	·866	·830	1·0	·95	·999	1·293	·82
Brass. . .	·909	·867	1·05	1·0	1·04	1·375	·858
Gun-metal .	·868	·828	1·002	·955	1·0	1·292	·825
Lead . . .	·67	·64	·774	·737	·773	1·0	·63
Zinc . . .	1·06	1·01	1·22	1·165	1·21	1·58	1·0

The weight of aluminium when compared with copper is as 1 to 3·6; gun-metal, 3·3; brass, 3·1; steel, 2·9. Brass is from 2 to 4 per cent. lighter than copper, specifically.

Comparative Weight of Metals.—Table II.

Metals.	Weight per sq. ft. 1 in. thick.	Approximate Percentage.	
		Heavier than Iron.	Lighter than Iron.
Iron, rolled	40·000	..	..
Steel ,, ...	40·833	2 per cent.	..
Brass ,, ...	43·68	7 ,,	..
Copper ,, ...	46·51	13 ,,	..
Gold ,, ...	100·8	150 ,,	..
Lead ,, ...	59·80	50 ,,	..
Nickel ,, ...	43·2	7 ,,	..
Silver ,, ...	54·75	36⅞ ,,	..
Tin ,, ...	38·0	..	5 per cent.
Zinc ,, ...	37·6	..	6 ,,
Aluminium, rolled . .	14·126	..	62·91 ,,

Properties of Metals, Alloys, Metalloids, and Artificial Substances used in Foundries.

Metals.	Symbol.	Specific Gravity.	Weight of a cub. ft. in lbs.	Tenacity in lbs. per sq. in.	Crushing Force in lbs. per sq. in.	Melting Point. °F.
Aluminium	Al	2·56	160	15,120	..	1157
Antimony	Sb	6·71	418	1,066	..	810
Bismuth	Bi	9·82	615	3,250	..	497
Cadmium	Cd	8·60	536	..	..	608
Copper (cast)	Cu	8·89	555	19,072	11,700	1996
Gold	Au	19·25	1203	20,400	..	2016
Iron (cast)	Fe	7·18	448	19,000	92,000	2786
Lead (cast)	Pb	11·4	711	1,824	7,000	620
Magnesium	Mg	1·74	108	..	..	1472
Manganese	Mn	8·00	499	..	..	2550 (about)
Mercury	Hg	13·56	847	..	..	−39
Nickel (cast)	Ni	8·28	516	..	..	2500 (about)
Platinum	Pt	21·5	1342	..	..	3640 (about
Silver	Ag	10·5	654	41,000	..	1733
Tin	Sn	7·4	462	5,000	15,000	442
Tungsten or Wolfram	W	19·8	1236	..	..	5000 (about)
Zinc (cast)	Zn	6·86	428	8,000	..	779
Metalloids.						
Arsenic	As	5·7	..	..	..	..
Carbon	C	1·9–3·51	..	..	..	..
Phosphorus	P	1·8	..	..	..	111
Silicon	Si	2·0	..	..	..	..
Sulphur	S	1·98	..	..	..	239
Alloys.						
Aluminium bronze (5 % Al)		7·68	480	71,680	..	1900
Brass (tube) (67 : 33)		8·43	526	26,600	..	—
Brass (cast) (2 : 1)		8·4	525	17,978	10,300	1800
Naval brass (rod)		..	..	60,480	..	1832
Muntz metal (rolled)		8·405	524	62,720	..	—
Delta metal (rolled)		8·45	527	91,800	..	1850
Gun-metal (88 : 12)		8·56	534	36,500	..	1900
Phosphor bronze		8·60	536·8	38,208	..	1800
Steel (average)		7·85	489·5	120,000	..	3250
Iron (No. 3 Pig)		7·126	444·6	21,859	91,661	—
Iron (No. 1 Pig) (cold blast)		7·137	446	23,257	95,775	—
Aluminium brass (2 % Al)		8·33	..	70,000	..	—

Specific Gravity of Miscellaneous Substances.

Asbestos	2·10 to 2·80	Pitch	1·07
Calcium	1·58	Sal-ammoniac	1·46
Cement	2·72 to 3·2	Salt	2·14
Chalk	1·8 to 2·7	Soapstone	2·6
Charcoal	0·36	Wax	0·97
Coal	1·37	Wood, Beech	0·75
Coke	0·5 to 0·8	„ Pine	0·47
Core gum	1·15	„ Oak	0·62 to 0·85
Fluor-spar	3·15	„ Ebony	1·19
Graphite	1·8 to 2·35	Cork	0·24 to 0·29
Limestone	2·59	Fir	0·56
Mica	2·78 to 3·15	Mahogany	0·8
Sand	1·9 to 2·5	Clay	2·0

To Convert Degrees Centigrade into Degrees Fahrenheit.

Let F = No. of degrees Fahrenheit.
C = No. of degrees Centigrade.

$$F = \frac{9}{5}C + 32, \quad \text{and } \textit{vice versa} \quad C = \frac{5}{9}(F - 32).$$

Freezing point, or 32° Fahr. = Zero in Centigrade.
Boiling point, or 212° Fahr. = 100° Centigrade.
1° Fahr. = 0·556 Centigrade.

Weight of Castings by Weight of Patterns.

Weight of Pattern, White Pine	×16	= Weight in	Cast Iron.
„ „	×17	= „	Malleable Iron.
„ „	×17·3	= „	Steel.
„ „	×18	= „	Copper.
„ „	×25	= „	Lead.

In general practice the weight of pine pattern multiplied twenty times is taken as the mean weight of casting and runners in brass or gun-metal.

Weight of Cast-Iron Balls.

Rule : $\dfrac{(\text{diam. in inches})^3}{2} \times 1 \cdot 1 = \text{W weight in lbs.}$

Or, $\dfrac{\text{cube of the ball's diam.}}{8} \times 1 \cdot 1 = \text{W weight in lbs.}$

A square foot of cast iron 1 inch thick weighs $37\frac{1}{2}$ lbs. To find what a square foot of any other thickness will weigh, multiply 37·5 by the thickness in inches or fractions of an inch.

Rule for Camber in Patterns liable to produce Distorted Castings.

Camber equals half the contraction allowance (lineal), and is set in the opposite direction from the bend in distorted casting.

Rule for Shrinking Brass Liners on Tail Shafts.

Bore the liner $\frac{1}{50}$th per foot diam. smaller than the finished size of the shaft upon which it is to be shrunk.

NOTES ON TEST BARS.

THE test bars desirable for ordinary cast-iron work are as follows:—

Transverse Strength. Bar 1 inch by 1 inch by 14 inches.—This bar should be broken with 12 inches between supports and load in centre. It is useful chiefly for the information it gives as to the elasticity of the metal; hence, a means should be provided for not only ascertaining its deflection under breaking load, but the maximum load it will carry with deflection and return to its original straightness. A metal which is close-grained and firm, with high elasticity, may be more valuable than another whose ultimate tensile strength is higher, but whose elasticity is of low degree.

Tensile Strength. Bar 14 inches long, $1\frac{1}{2}$ inches in diameter at ends, with area reduced at centre, preferably to 1 square inch or $1\frac{1}{8}$ inch diameter.—Where diameter is 1 inch, the machine reading must be divided by ·7854 to get tensile strength per square inch. These bars may be tested with the skin of the metal on them, and, if desired, other bars of the same section may be turned down from 3-inch diameter bar to get strength of the metal at the heart of the bar.

Fracture. Bar 4 inches by 6 inches by 1 inch.—This bar or plate to be cast with the 6-inch edge against a chill. The test break is made through the chill, and the fracture gives the depth of chill and nature of iron. The influence of the metalloids—notably manganese and sulphur—may be judged by the depth of the chill. It may be in general emphasised here, however, that gradation by fracture is only a comparative test, as the effect of the metalloids is bound by their action on the relation of the carbon to the iron, increasing or decreasing the affinity of these two for each other.

Solidity and Homogeneity. Angle bar, 2¼ inches by 2¼ inches by 1 inch by 6 inches.—This bar is supposed, the extreme conditions which exist in a flanged casting, the corner being sharp. The test break is made by splitting through the corner, when the tendency to segregation, the formation of pockets, and the general nature of the fracture may be noted.

Shrinkage. Bar, 8 feet long.—The shrinkage per foot is best determined by a bar this length, although a square bar, 1 inch by 1 inch by 12 inches, with ends cast against a chill, answers the same purpose.

The Drop Test is sometimes substituted for the usual tensile test. The following description, by

Mr. W. G. Scott, of a machine, and the method of carrying out the test, appeared in *The Foundry*, August 1901.

"Our drop test machine is built on the principle of a pile-driver, with two upright posts 12 inches apart.

A frame 12 inches wide and 18 inches long, slides up and down between the upright posts; on the lower end of this frame is attached the iron striking block made in the shape of a wedge with an oval hardened steel face ½ inch wide.

The frame and parts weigh 10 kilos, or about 22 lb. The frame or weight is pulled up to a certain height and then automatically released by means of a suitable trip. A fall of 1 inch is equivalent to 22 inch-lb., a 2-inch drop is equivalent to 44 inch-lb., and a drop of 12 inches is calculated as 264 *inch*-lb. or 22 *foot*-lb.

With a 1-inch-square test bar placed on supports 12 inches apart, we start with a 3-inch drop, and increase the height of the fall or drop by 1 inch each time until the bar is broken.

For example, we may illustrate the method on paper as follows:

First drop (1 blow) 3-in. fall	66	inch-lb.
Second drop (2 blows) 4-in. fall	88	,,
Third drop (3 blows) 5-in. fall	110	,,
Fourth drop (4 blows) 6-in. fall	132	,,
Fifth drop (5 blows) 7-in. fall	154	,,
Total, 25-in. fall	550	,,

This would be reported as 5 blows, a total fall of 25 inches, and equivalent to 550 inch-lb.

This is our method of making the drop test, but it does not necessarily follow that it is the best method; some experimenters prefer a given height for the drop and repeat the fall until rupture occurs, in which case the *number of blows* is the main feature.

Castings in actual service are generally subjected to shock, consequently it seems to us that more attention should be given the drop test method of determining the strength.

It has been found from numerous experiments that a square test bar having a *tensile strength* of, say 24,000 lb., will have a *transverse strength* of about 2,400 lb., and a *shock resistance* of 240 inch-lb."

Chill.—The chilling properties of cast iron are determined in several ways.

In order to get the exact measurement, it is better to get a print from an etching in the following manner.

Grind off one side of the chilled end of the bar, using an emery wheel or grindstone, then polish with flour of emery to remove scratches. Wash the polished surface with weak ammonia and then with clear water to remove the grease, etc., after which place in an etching solution for about 15 minutes.

The etching solution is made by pouring 3 fluid oz. of strong sulphuric acid into 9 fluid oz. of distilled water, then adding 1 fluid oz. of strong muriatic acid.

Make the mixture in an earthenware jar, as the heat of the mixture will be liable to break a glass vessel.

Never pour the water into the acid, but *add* the sulphuric acid slowly in a thin stream and stir well.

When the piece is well etched, rinse in clear water, then wipe dry.

With a printer's roller give the face of the etching a coat of ink, then by means of a letter press or by bearing down hard with the hand, you can get a print showing the chill.

Below is an exact reproduction of an etching showing the chill on a test bar.

CAST-IRON SCRAP.

Its Value and Classification.

The following classification of scrap is suggested, each pile to be carefully separated in the yard.

1. *Stove Plate.*—Rich in silicon, carbon and phosphorus. Its chief objection is the great amount of oxide which collects on its surface in proportion to weight.

2. *Agricultural Machinery.*—Equally as rich in carbon as No. 1, but not so high in silicon and phosphorus.

3. *Light Machinery.*—Not so high in silicon and phosphorus, but about a medium between extremes.

4. *Heavy Machinery.*—This consists of heavy gearing, housings, rolls, etc.; low in silicon and phosphorus, but rich in carbon.

5. *Fire Bars, Furnace Plates.*—Castings that have been exposed to heat. This is the lowest grade of scrap iron, having been depleted of most of its life-giving properties.

Silicon is recognised as the element which produces soft iron with low shrinkage. As a guide in making up mixtures,

Stove plate scrap may be reckoned to contain			2·75	Silicon
Ordinary machinery scrap	„	„	2·00	„
Heavy „ „	„	„	1·75	„

In these days of cheap castings, a pig-iron which will perform the functions of a good scrap-carrier is essential.

From 25 per cent. to 40 per cent. scrap is a good average for general work.

In calculating mixtures, allowance should be made for variations in melting, thus:

Silicon may be reckoned to lose about				..	·25	per cent.
Manganese	„	„	„ „	..	·20	„
Sulphur	„	„	increase „	..	·04	„
Phosphorus	„	„	„ „	..	·005	„
Total Carbon	„	„	as stationary.			

Although it may either lose or gain, according to the speed and conditions of melting.

SHOP RECEIPTS.

To prevent damp sand from sticking to wood or metal patterns, dust on lycopodium.

To free brass from iron turnings, salt them well, moisten thoroughly, and after a few days wash with running water.

To take the temper out of cast steel for turning, make it a dark cherry red, and bed in dry lime.

To melt steel or wrought iron turnings and improve cast iron, put from 12 per cent. to 20 per cent. of the capacity of the ladle into the bottom, making sure that the turnings are dry, and pour good hot iron in by tapping the cupola.

Mixture for tough or hydraulic cast iron: grey iron, No. 3 pig, 32 cwt.; steel (boiler-plate punchings, test pieces, etc.), 18 cwt., divided into five equal charges.

Core compound, used in steel and brass foundries: 1 quart linseed oil to 2 bushels sand.

Facing for steel castings: 4 parts black sand; 1 part white sand; ½ part fireclay; ¼ part chloride of ammonia. The hot metal coming in contact with the facing, decomposes the chloride and forms a gas, which in its nascent state cleans the face of the castings.

To liven dull iron and prevent shrink holes, drop a small piece of *dry* zinc into the ladle. Aluminium has a similar effect.

Core sand mixture for intricate castings: 6 quarts fine lake or silica sand, 1 quart flour, ¼ pint linseed oil.

Flux for welding copper: boracic acid 2 parts, phosphate of soda 1 part; mix. Heat the copper pieces in a flame or gas jet, where they will not touch charcoal or solid carbon; strew the powder over the surfaces at a red heat, continue heating to welding point, then hammer.

Aluminium can be cleaned and its mat restored by dipping for 1¼ minutes in 3 oz. of caustic potash or soda in a quart of water, then washing well, and dipping in a solution of 3 parts nitric acid and 3 parts sulphuric acid (by volume).

Delicate cores made with moistened core-gum, or good sea sand, *without vents*, never blow.

Annealing cast iron: To anneal cast iron, heat it with a slow charcoal fire to a dull red heat, then cover it over about 2 inches with fine charcoal, then with ashes; let it lie until cold. Hard cast iron can be softened enough in this way to be filed or drilled. This process will be extremely useful to ironfounders, as by this means there will be a great saving of expense in making new patterns. To make a casting of precisely the same size of a broken casting without the original patterns, put the pieces of broken casting together and mould them and cast from this mould. Then anneal it as above described. It will expand to the original size of the pattern and there remain in that expanded state.

To harden cast iron: Many times it is very convenient to make an article of cast iron that needs to be finished, and which should be very hard. Cast iron can be hardened as easily as steel, and to such a degree of hardness that a file will not touch it. Take ½ pint of vitriol; 1 peck of common salt; ½ lb. saltpetre; 2 lb. alum; ¼ lb. prussic potash; ¼ lb. cyanide of potash; all to be dissolved in 10 gallons of soft water. Be sure that all the articles are dissolved. Heat the iron to a cherry red and dip it in the solution. If the article needs to be very hard, heat and dip the second and even the third time.

For burns, the famous carron oil is a specific which should always be at hand in the foundry. Equal parts of linseed oil and lime-water make a soothing dressing; but for killing pain and taking the heat out of burns there is nothing to equal dilute picric acid. It acts like magic. Dissolve 1 oz. in a quart of water.

Furnace lining is a fad with many foundrymen. Ground ganister is the standard substance employed. Two parts fireclay, 1 part ground firebrick and 2 parts old crucible (ground), is an excellent mixture for this purpose.

A rustless coating for steel is a solution of white wax in benzene, applied with a camel-hair brush. When the film of wax hardens, the bulk of it is wiped off with a chamois leather, just sufficient remaining to prevent rust.

A quick method of breaking up large castings is as follows: Take, for example, the case where old and heavy machinery has to be pulled out, and where, very often, the parts are so corroded that they cannot be detached except by breaking them. The usual method when the sledge-hammer is not heavy enough to break the metal, is to drill a number of holes, and then use a chisel or drift to sever the metal between each hole. Sometimes several inches of solid metal have to be drilled through before anything effective can be accomplished. A better way is to drill one or two holes 1 inch diameter partly through the metal, after which partially fill them with water. Then take a round drift with a diameter slightly less than the hole, place the same in the hole, giving it a sharp blow, when the hydraulic pressure thus occasioned will split the metal readily.

To produce a brilliant or dead black on brasswork, take a $\frac{1}{4}$ lb. of copper carbonate and dissolve in $1\frac{1}{2}$ pints water; next get about a pint of dilute ammonia, add very gently to the copper solution till the precipitate which is formed is re-dissolved. Care must be taken not to add too much ammonia; and the solution should be made in a crock or enamelled pan, and used cold. The articles to be blacked are previously cleaned in the ordinary acids.

To ascertain how many bushels of coke are required for a bed for a cupola, divide the cubic inches in the space to be filled (measuring from the sand bottom to the desired height above the tuyeres, say 20 inches) by the cubic inches in a bushel of coke. The average bushel of coke numbers 2200 cubic inches.

Cement for stopping holes in castings: Sulphur, 1 part; sal-ammoniac, 2 parts; iron filings, 80 parts. Triturate and mix into a paste.

Another: Iron filings, 15 parts; sal-ammoniac, 2 parts; sulphur, 1 part; Portland cement, 2 parts. Mix no more than can be used immediately.

Hand-made loam: Fire-sand, 7 parts; moulding-sand, 2 parts; horse manure, $1\frac{1}{2}$ parts. Mix with thick clay-water.

"*A new Method of Repairing Brass Furnaces.*—The rebuilding or relining of brass furnaces is not the big job it once was. Most of the up-to-date foundries have "caisson furnaces" which only require relining occasionally. Some firms, instead of using bricks for this purpose, get fireclay liners made in one piece, to slip into the casing. But an idea struck us as a good way of using up old material. A plug was made with a hole through it to allow an eye-bolt to pass (an old liner pattern would do). When the casing was stripped this was set in position, and a plate large enough to cover the bottom of the furnace fastened to it from below. The space between the casing and the plug was then filled up with a mixture of fireclay and broken firebricks, made like concrete; this was rammed up and allowed to set. The result was a lining equal in wear to the best firebrick."—*Feilden's Magazine,* July 1902.

Core sand mixture (American): Silica moulding sand, 3 parts; cotton seed meal, 1 part; pulverised rosin, $\frac{1}{2}$ part. Mix with water to the same dampness as moulding sand. Cores made with this mixture will neither sag nor blow.

Loam mixture for heavy brass castings: Sharp sand or fine gravel, 6 parts; rock sand, 1 part. Mix with thick clay-water, then mill or cut on a slab for 20 minutes, or till it becomes adhesive. The same mixture, with 1 part horse droppings added, is suitable for cast iron.

To obtain a core model of regular thickness: Make a sand mould from the casting or pattern; melt sufficient sulphur to fill it. Cast upon end, and have a riser about the diameter of the largest part of the casting. Watch the sulphur setting in the riser, and when the desired thickness has set, turn the mould upside down and empty the remaining liquid sulphur out. Into the shell of sulphur left in the mould, pour plaster of Paris. When set, open the mould, and crack off the sulphur thickness from the plaster core model.

To extract a rusty screw from a pattern: Flatten one end of a piece of bar iron; make it red hot, and expand the screw by placing it on the head. In a few minutes the screw can be drawn with the screw-driver.

Waterproof glue for patterns: A glue that will withstand damp can be made by making ordinary glue with linseed oil, instead of water. Boiling 1 lb. of glue in 2 quarts of skimmed milk also does well.

The best of all waterproof glues is got by cutting 1 oz. of indiarubber into threads with a wet knife, putting this into a wide-mouthed pickle bottle, and filling up with either benzine or naphtha, loosely corking the bottle, and letting it stand in a warm place away from flame until melted in a week or ten days. Shake occasionally. Thin with benzine; thicken with rubber.

Sea coal facing: Sand mixtures average, according to weight of castings: sea coal, 8 per cent. to 12 per cent. added to half old and half new sand.

Cupola daubing: Equal parts kaolin and rock sand, mixed with clay-wash, forms an excellent daubing material. Ground firebrick or old cupola blocks, mixed with fireclay or old crucibles (ground), make the best cupola daub known.

Dry sawdust makes a splendid flux for Babbitt metal.

To keep the sand from clogging a metal pattern, give it a coat of beeswax, or wash it over with kerosine immediately before using. Sal-ammoniac acts in the same way on brass patterns.

One ton of fireclay should be sufficient to lay 3000 ordinary bricks.

A 9-inch brick weighs 7 lb.

One cubic foot of wall requires 17 9-inch bricks; 1 cubic yard requires 460. Where keys, wedges and other shapes are used, add 10 per cent. in estimating the number required.

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