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Tom Summerville

"The Practical Brass and Iron Founder's Guide
A Concise Treatise
on the art of
Brass Founding, Moulding, etc.
with numerous
Practical Rules, Tables, and Receipts
for
Gold, Silver, Tin and Copper Founding;
Plumbers, Bronze and Bell Founders,
Jewellers, Etc., Etc.
By
James Larkin
Conductor of the Brass Foundry Department
in Reaney, Neafie & Co's
Penn Works, Philadelphia

Philadelphia:
A. Hart, late Carey & Hart.
126 Chestnut Street
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Printers

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RECOMMENDATIONS.

WOOLWICH DOCK-YARD, 17th April, 1851.

These are to certify, that James Larkin was employed as leading man of brass founders, in the Steam-engine Factory of this Yard, from the 30th day of November, 1840, to the 12th day of April, 1851. During the last 2¼ years he has been under my superintendence, and his capability as a workman has been quite satisfactory to me.

EDW. HUMPHREYS,
Chief Engineer.

PHILADELPHIA, December 7, 1852.

GENTLEMEN:

Mr. James Larkin has been conductor of the Brass Foundry Department in our establishment for the last twelve months. We have every confidence in his ability, and consider him to be at the head of his profession.

We have taken a cursory view over the work he is about publishing, and feel fully satisfied that it is what is much needed in the Trade. It is a desirable work for the pocket—for the artist as well as the mechanic.

Respectfully yours, &c.,
REANEY, NEAFIE & CO.,
Penn Works.

as that described under "Loam-moulding." It is not essential to have all patterns exactly of the thickness of the casting wanted, as it is often cheaper to take a thickness off the pattern in manner afterwards explained.

MOULDING.

THE APPARATUS AND MATERIALS.

Brassfounders' furnaces are mostly sunk under the floor level; the pit for the removal of the ash is covered by hinged iron gratings. The covers for the furnace-top are constructed of cast iron, and usually dome-shaped, though not necessarily; a damper is inserted in the flue to regulate the draft. The internal building of the furnace is of fire-brick, grotted with fire-clay.

In large works it is common to have an air-furnace, instead of the ordinary one (Fig. 2). The difference exists in the admission of a blast under the furnace bars, and stopping up the ordinary opening at the ash-pit. The blast is obtained from a patent fan, driven by the engine.

Throughout the country there are almost an endless quantity of small brass-foundries, where the

regular furnace cannot be applied. The stove-furnace (Fig. 3), or a modification of it, is generally

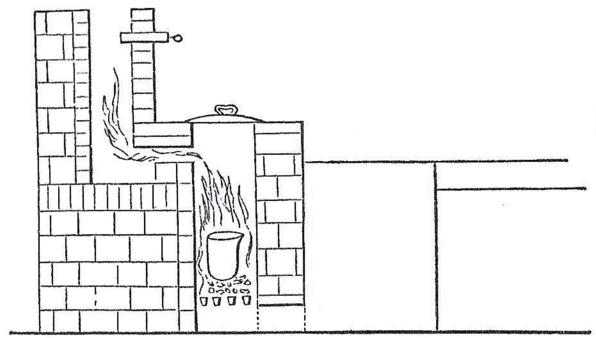

Fig. 2.—Ordinary Melting Furnace.

adopted. The third furnace (Fig. 4) is only intended for small work; it is extremely clean, and

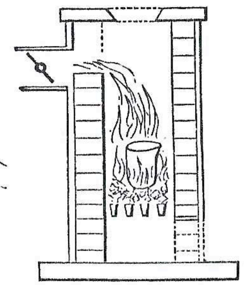

Fig. 3.—Stove Furnace.

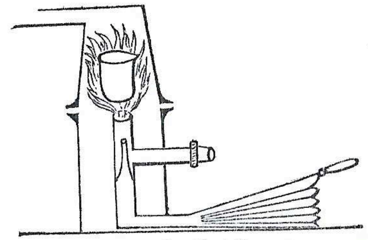

Fig. 4.—Gas-Blast Furnace.

can be used on a bench; the kneed-pipe over the crucible is made of fire-clay. The heat from this furnace is most intense.

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In passing, it may be well to explain that fire-clay is a compound of silica, alumina, and water, mixed to a greater or less extent with foreign substances. The bricks are made from pounded clay, in other respects like ordinary bricks. The foreign matters are chiefly oxide of iron, lime, magnesia, black lead, and bitumen. These contaminations impair the value of the clay, and render it less fit for standing fire. Pure clay is white, opaque, and unctuous.

Next in importance to the furnaces are the crucibles; these should not corrode, should not allow liquids or gases to pass through them, and should resist every sudden change of temperature.

The common crucibles are made from

1 part fire-clay,
2 parts black lead.

The Berlin crucibles consist of

8 parts fire-clay,
4 parts black lead,
5 parts powdered coke,
3 parts old ground crucibles.

The Stourbridge crucibles are composed of

4 parts fire-clay,
2 parts burned-clay cement,
1 part ground coke,
1 part ground pipe-clay.

Mr. Austey's patent crucibles contain

2 parts fire-clay,
1 part ground gas-coke.

The crucibles in general use are known as *blue pots*; they consist chiefly of fire-clay and black lead; they are manufactured either as pottery-ware, on a wheel, or by mould and mandrel. The materials should be free from lime, and wrought as compacted as possible, and slowly dried in a kiln.

When fire-clay cannot be had, common clay, steeped in hot hydrochloric acid, and well washed with hot water, and dried, may be substituted.

CRUCIBLE TONGS.

Fig. 5 exhibits the forms of tongs best suited for furnace-work. The great object is to hold the

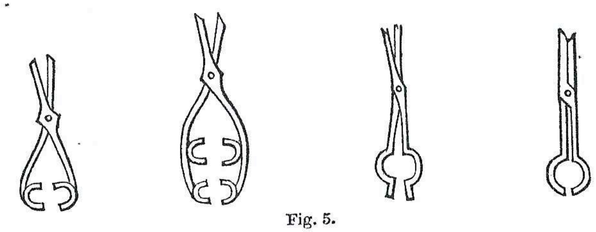

Fig. 5.

crucible fast. These tongs should be strong, and of various sizes.

FUEL.

Hard coke is generally employed for brassfounders' furnaces and stoves. Coke should leave only a small per-centage of ash, and should practically convert six to eight pounds of water into steam, for every one

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pound of coke consumed. Much larger quantities are commonly published, but they relate to theoretical quantities, making no allowance for the lost heat which passes up the chimney. Gas-coke is also very much employed; it has the advantage of cheapness.

DRYING-STOVE.

Fig. 6 exhibits a drying-stove, half open; the fire is placed on the lower grating: the air is admitted

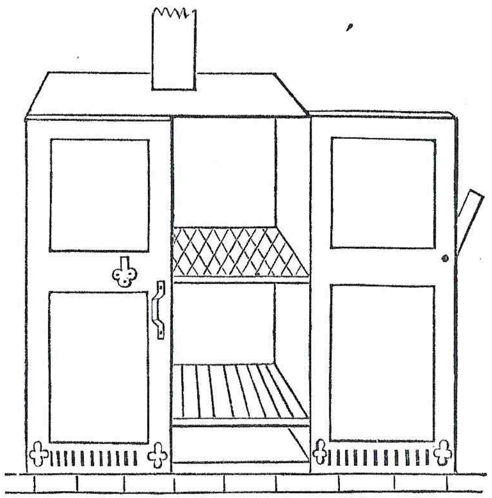

Fig. 6.

through openings at the foot of the doors, or from under the doors when made a little shorter than the size; the mould-boxes and cores are placed on the

upper grating, and the draft conducted to the flue on the top of the stove. The doors are made of iron, the other three sides of stone or brick. The size will depend on the extent of work. Drying-stoves are beneficial, on account of so much damp sand and loam being used by the moulders; their use produces sounder and sharper castings, as will be explained under "Sands."

A much cleaner stove is obtainable by making a steam-tight jacket for the stove, and so heating it with the exhaust steam from the engine. This saves space and all the fuel for this stove, as well as the time wasted in attending to it. In this case the stove must be made wholly of iron.

For small cores it is exceedingly convenient to have an ordinary range-oven, mounted with a steam-jacket or case in the same way, and supplied with steam also from the exhaust. Care must be taken, however, to let the steam have an outlet.

MOULDING-TUB AND TOOLS.

The construction, nature, and application of the respective parts of the apparatus given in Fig. 7 will be apparent at a glance. The moulding-tub requires to be made very strong; it is constructed of wood, and provided with sliding bars, and a quantity of one-inch boards, with cross ends, the size of the moulding-boxes. The moulding-boxes are simply

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rectangular rims of iron, with snugs and pins exactly fitted, so that when the one half is placed upon the other there will be no possibility of shifting a hair's-breadth. The cramps are made of wood, sufficiently long to clasp the moulding-boxes lengthwise.

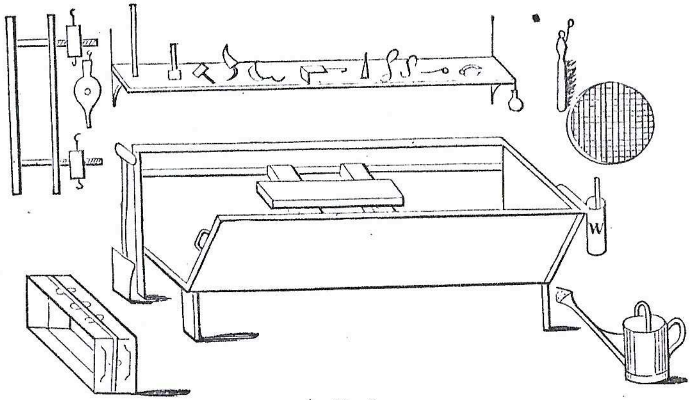
Fig. 7.

When the boxes are large, several bars are cast across them. When the boxes are subject to much rough work, the bars are best made of malleable iron, cast in; where lightness is desirable in large boxes, they should be entirely made of malleable iron.

SANDS AND FACING MATERIALS.

Sand.—Moulding may be executed in many substances, but none so conveniently or so perfectly as

sand, containing a little loam or clay. The greater the quantity of pure sand or silex, the more readily will the gases generated at pouring escape, the less risk of blown-holes, and the greater chance of a good casting. The greater the quantity of loam or clay, the more perfect will be the impression, but the greater risk of spoiled castings. These remarks apply only to green-sand casting, as the difficulty is altogether removed by using the drying-stove.

Sands for moulding purposes, though varying in grain, have the composition of about

94 parts silex,
4 parts clay,
2 parts oxide of iron and impurities.
———
100

Lime, magnesia, and metallic oxides are detrimental substances to the moulder, and sands containing them in any larger proportions than above should be avoided. They do not stand the heat; they melt in the presence of the poured metal; they boil, unite with and blister the surface of the casting; they generate gases, cause hosts of air-holes, and destroy more than the sand is worth.

Moulding-sand is obtained from the beds of large rivers, in the vicinity of granite or slate mountains; in the rivers of coal districts, if the iron is not too abundant; but never in mica, lime, or volcanic districts.

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Core Sand.—This sand, though gritty and porous, must be adhesive, fresh, and pure. Rock sand, that is, the accumulation of washed sand, from a newly broken primitive or felspar rock, receives the preference; where this is not to be had, pounded blast-furnace cinder, tempered with a little clay, may be used; failing both, free sand, mixed with clay or barm, may be employed.

Parting Sand.—This may be either red brickdust, fresh free sand, sea or river fine sand, or blast-cinder powder. It must be a substance which does not retain damp; preference being given in the order above indicated.

Facing the Sand.—When hot metal comes in contact with fresh sand, the sand partially melts, and a rough casting is the result. To obviate this, fine charcoal is dusted upon the mould, or the mould is smoked with cork shavings or pitch torches, by which a very fine deposit of carbon is obtained, and a smooth skin secured to the casting. Carbon does not adhere well to old sand; when it is used, it is necessary, first, to dust the mould with pease-meal, and then add the carbon. Avoid excess of both, otherwise the casting will come out faint, instead of sharp, the carbon collecting in the hollows and preventing the metal running up.

MANIPULATION.

Ordinary plain work is arranged according to circumstances in the flask. Fig. 8 shows a general arrangement. When only one or two castings are

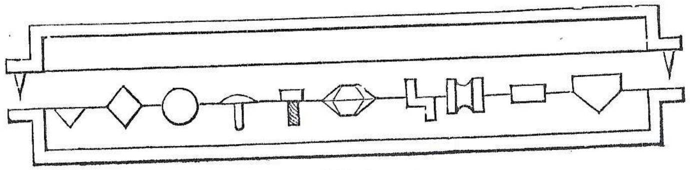

Fig. 8.

required from a pattern, the pattern is "rapped" into the flask, that is, the top part being rammed up, a portion of the sand is removed, and the pattern inserted, or "rapped in." After sprinkling on some parting sand, the drag is placed on, and facing sand sieved in, after which the ordinary sand is rammed in till the flask is full; then the flasks, top and drag, are turned over so that the drag is lowest, when the top part is taken off and emptied, the face of the drag cleaned again, and dusted with parting sand. After this, the top part is put on, and filled and rammed with facing and ordinary sand, as was done above. The top part is again removed, and the patterns withdrawn. In the process of parting the box and withdrawing the patterns it often occurs that part of the sand is torn away, which in con-

'y appear stony, at other times stances they are crystallized ut more commonly they occur The ores are chiefly found in fissures of rock, especially the d limestone rocks; but some- in rounded and detached frag- through certain alluvial and earth. The extraction of the lenominated their *reduction*, us series of operations, me- l, comprehended under the

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The following table contains an enumeration of the metals, and may be useful for reference. The column headed "equivalents," shows the weight which unites with 8 oxygen to form the oxides, and the succeeding column contains the symbols by which the metals are denoted in systematic chemistry.

Names of Metals.	Authors, and Dates of their Discovery.	Specific Gravity.	Melting Points. *Fahr.*	Equ. Hyd. = 1.	Abr. or Sym.
1. Gold (Aurum)	Known to the ancients.	19.25	2016?	200	Au.
Silver (Argentum)		10.47	1873	108	Ag.
Iron (Ferrum)		7.78	*2800?	28	Fe.
Copper (Cuprum)		8.89	1996	64	Cu.
Mercury (Hydrargyrum)		13.56	—39	200	Hg.
Lead (Plumbum)		11.35	612	104	Pb.
Tin (Stannum)		7.29	442	58	Sn.
Antimony (Stibium)	Basil Valentine 1490	6.70	. .	65	Sb.
Bismuth	Agricola . . 1530	9.80	497	72	Bi.
Zinc	Paracelsus? . 1530	7.00	773	32	Z.
Arsenic	Brandt . . 1733	5.88	. .	38	Ar.
Cobalt		8.53	2810?	30	Co.
Platinum	Wood . . . 1741	20.98	oh. bp.†	99	Pl.
Nickel	Cronstedt. . 1751	8.27	2810?	30	Ni.
Manganese	Gahn . . . 1774	6.85	s. f. *	28	Mn.
Tungsten (Wolfram)	D'Elhuiart . 1781	17.60	. .	100	W.
Tellurium	Muller. . . 1782	6.11	620?	32	Te.
Molybdenum	Hielm . . . 1782	7.40	oh bp	48	Mo.
Uranium	Klaproth . . 1789	9.00	oh bp	217	U.
Titanium	Gregor. . . 1791	5.30	oh bp	24	Ti.
Chromium	Vauquelin . 1797	. .	oh bp	28	Cr.
Columbium (Tantalum)	Hatchett . . 1802	. .	oh bp	185	T.
Palladium	Wollaston . 1803	11.50	. .	54	Pd.
Rhodium		. .	oh bp	52	R.
Iridium	Tennant . . 1803	. .	oh bp	99	Ir.
Osmium		. .	oh bp	100	Os.
Cerium	Hisinger . . 1804	. .	. .	48	Ce.
Potassium (Kalium)	Davy . . . 1807	0.86	136	40	K.
Sodium (Natronium)		0.97	190	24	Na.
Barium		. .	. .	70	Ba.
Strontium		. .	. .	44	Sr.
Calcium		. .	. .	20	Ca.
Cadmium	Stromeyer . 1818	8.60	442	56	Cd.
Lithium	Arfswedson . 1818	. .	. .	8	L.
Silicium	Berzelius . . 1824	. .	. .	8	S.
Zirconium		. .	. .	33	Zr.
Aluminum	Wohler . . 1828	. .	. .	14	Al.
Glucinum		. .	. .	18	Gl.
Yttrium		. .	. .	32	Y.
Thorium	Berzelius . . 1829	. .	. .	60	Th.
Magnesium	Bussy . . . 1829	. .	. .	13	Mg.
Vanadium	Seffstrom. . 1830	. .	. .	69	V.
Lantanum	Mosander . 1840	. .	. .	?	Ln.

* Smith's forge. † Oxy-hydrogen blowpipe.

4

COPPER AND TIN.

1	ounce,	Soft gun metal.
$1\frac{1}{4}$	"	A slightly harder alloy, fit for mathematical instruments.
$1\frac{1}{2}$	"	Still harder, fit for wheels.
$1\frac{1}{2}$ to 2	"	Brass guns.
2 to $2\frac{1}{2}$	"	Hard bearings for machinery.
3	"	Musical bells.
$3\frac{1}{2}$	"	Chinese gongs, cymbals, &c.
4	"	Small house bells for domestic purposes.
$4\frac{1}{2}$	"	Large do.
5	"	Largest bells, for churches, &c.
7 to 8	"	Speculum metal for the reflectors of telescopes, light-houses, &c.

Temper, is a mixture of 2 pounds of tin to 1 pound of copper, and is used for adding to tin in the manufacture of pewter; the object being to introduce an extremely small quantity of copper.

BRONZE FOR CANNON, STATUES, ETC.

BRONZE is an alloy of copper, with from 8 to 10 per cent. of tin, together with small quantities of other metals, which are not essential to the compound. Cannons are cast with an alloy of a similar kind, and the ancient bronze statues were of the same composition.

ON BELL METAL.

BELL METAL is a compound of 80 parts copper to 20 parts tin. The Indian gong, so much celebrated for the richness of its tones, contains copper and tin, in the above proportions. The proportion of tin in bell metal varies, however, from one-third to one-fifth of the weight of copper, according to the sound required, the size of the bell, and the impulse to be given. M. de Arcet has discovered that bell metals formed in the proportion of 78 parts copper, united with 22 of tin, is indeed nearly as brittle as glass, when cast in a thin plate or gong. Yet if it be

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heated to a cherry-red, and plunged into cold water, being held between two plates of iron, that the plate may not bend, it becomes malleable. Thus he manufactures gongs, cymbals, and tantums out of this compound.

ON COPPER AND TIN MIXTURES.

THE above are the best proportions in use at the present day; for some other peculiar objects a slightly different mixture is adopted, as a small amount of zinc or silver, and even arsenic. The best mode of mixing the component metals of this alloy, appears to be to melt each separately, and then to add the tin to the copper at the lowest stirring temperature. To complete the combination the alloy is again melted very gradually by placing the metal in the crucible almost as soon as the fire is lighted. The hardness of this alloy, compared with the extreme softness of the metals, gives us an example of the chemical changes effected by their combination. Thus, the speculum metal, as used by Lord Rosse, is totally devoid of malleability, and from its hardness cannot be acted on by the file.

His speculum consisted of four atoms of chemical combining proportions of copper to one of tin: or, by weight, 126.4 copper to 58.9 tin. This alloy, which is a true chemical compound, is of a brilliant white lustre; its specific gravity 8.811; nearly as hard as steel, and almost as brittle as sealing-wax. The speculum is six feet in diameter, five and a half inches thick. It was cast open, ground with emery, placed on a table in a cistern filled with water at a temperature of 55° Fahr., polished with red oxide of iron, procured by precipitation from green vitriol, or sulphate of iron, by water of ammonia.

ALLOYS OF COPPER AND ZINC.

WE now come to the consideration of another branch of the copper alloy family of great value in the arts. This is copper and zinc.

The following table contains the best proportions of the principal mixtures. In this table the quantity of zinc is that which is added to one pound of copper.

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The founder, then, must rely on his own judgment, as to what is the lowest heat at which good, sharp impressions will be produced. As a rule, the smallest and thinnest castings must be cast the first in a pouring, as the metal cools quickest in such cases, while the reverse holds good with regard to larger ones.

Complex objects, when inflammable, are occasionally moulded in brass, and some other of the fusible metals, by an extremely ingenious process; rendering what otherwise would be a difficult problem a comparatively easy matter.

The mould, which it must be understood is to be composed of some inflammable material, is to be placed in the sand-flask, and the moulding sand filled in gradually until the box is filled up. When dry, the whole is placed in an oven sufficiently hot to reduce the mould to ashes, which are easily removed from their hollow, when the metal may be poured in. In this way (as will be afterwards shown) small animals, birds, or vegetables may be cast with the greatest facility.

The animal is to be placed in the empty moulding-box, being held in the exact position required, by suitable wires or strings, which may be burnt or removed, previous to pouring in the metal.

Another mode which appears to be founded on the same principle, answers perfectly well when the original model is moulded in wax. The model is placed in the moulding-box in the manner detailed in the last process, having an additional piece of wax to represent the runner for the metal. The composition here used for moulding is similar to that employed by statue founders in forming the cores for *statues*, *busts*, &c., namely, two parts brick-dust to one of plaster of Paris. This is mixed with water and poured in so as to surround the model well. The whole is then slowly dried, and when the mould is sufficiently hardened to withstand the effects of the molten wax, it is warmed, in order to liquify and pour it out. When clear of the wax, the mould is dried and buried in sand, in order to sustain it against the action of the fluid metal.

If our limits permitted, we might mention the details of numerous other works in the founding of brass. We must for the present content ourselves with a brief examination of one or two cases which come more or less within the province of the engineer. One of these is the founding of bells, a subject of considerable interest, as works of this kind are often of very considerable magnitude, and demand the skilful attention of the engineer. Large

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bells are usually cast in loam moulds, being *swept* up, according to the founder's phraseology, by means of wooden or metal patterns, whose contour is an exact representation of the inner and outer surfaces of the intended bell. Sometimes, indeed, the whole exterior of the bell is moulded in wax, which serves as a model to form the impression in the sand, the wax being melted out previous to pouring in the metal. This plan is rarely pursued, and is only feasible when the casting is small.

The inscriptions, ornaments, scrolls, &c., usually found on bells, are put on the clay mould separately, being moulded in wax or clay, and stuck on while soft. The same plan is pursued with regard to the ears, or supporting lugs, by which the bell is hung.

BRASS GUNS

ARE another important branch of this manufacture. They are moulded in a manner quite distinct from any other work of this nature. The exterior surface of the gun is produced by wrapping gaskin or soft rope round a tapered rod, of a length slightly

greater than that of the gun. Upon this foundation of rope the moulding loam is then applied; the surface being turned to the exact shape and proportions of the gun.

A long fire is used by the founder in this process, in order to dry the mould as he proceeds in its manufacture. When perfectly dry, the surface of the mould is black-washed over, and again covered with loam to a depth of two or three inches. This exterior coat of loam is secured and strengthened by a number of iron bands, and the whole is well dried. The primary mould is now completely withdrawn from the outer shell, the formation of which renders it an easy matter, as the timber rod leaves the rope with great facility, when the latter may be withdrawn, and the clay covering picked out afterwards.

The trunnions of the gun are formed separately, and attached to the shell in the ordinary way. When finished, the moulds are sunk perpendicularly in a sand pit, near a reverberatory furnace, a vertical runner being made, leading to each mould, which it enters near the bottom. A suitable channel communicates with the furnace containing the brass intended for the guns. The metal being in-

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ON BRASS.

In Germany brass appears to have been made for centuries before the manufacture was introduced into England. This is stated to have been done by a German, who worked at Esher, in Surrey, in the year 1649. The analysis of a few pieces of bronze, of undoubted antiquity, namely, a helmet with an inscription (found at Delphi, and now in the British Museum), some nails from the treasury of Atreus, at Mycenæ, an ancient Corinthian coin, and a portion of a breast-plate, or cuirass, of exquisite workmanship (also in the British Museum), affords about 87 to 88 parts copper to about 12 to 13 tin, per cent.

The experiments of Klaproth and others give nearly the same results as to ingredients; the quantities sometimes slightly differ. Lead is contained in some specimens, as has been shown. Zinc, and the nature of it, as heretofore observed, was not known to the ancients.

In an antique sword, found many years ago, in

France, the proportions in 100 parts were, 87.47 copper, 12.53 tin, with a small portion of lead, not worth noticing.

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METHOD OF CASTING IN PLASTER—MEDALLIONS, ETC.

Obtain some fine plaster, of good colour, and pass it through a muslin sieve, to remove any coarser particles which may be present. By mixing *gum arabic* with the water intended to be used in the plaster, not only will the plaster be rendered very hard when it sets, but a beautiful gloss will be given to the surface. Care must be taken to drop the plaster powder gradually into the water, and to permit the bubbles to rise before the mixture is stirred; otherwise it will become lumpy. The plaster should be of the consistence of the yolk of an egg, and, of course, used immediately. If the medal intended to be copied is a valuable one, with a smooth surface, it will be advisable not to oil it, as, in cleaning the oil off, the polish may be injured; but if the surface be rough there will be no remedy, and the oil must afterwards be removed, by dabbing the surface of the medal gently with a soft cloth.

metals, namely, antimony, bismuth, cobalt, iron, nickel, and silver.

There is also found a native alloy of antimony and nickel, and of antimony, cobalt, and nickel; others might be mentioned; but there is no instance of a native alloy, strictly speaking, being applied to any useful purpose. Whereas, the artificial alloys, as has been fully shown, are of the highest importance, both for the uses of common life, and for manufacturing purposes. By uniting different metals, compounds are formed, which possess a combination of qualities not occurring in any one metal.

Platina is always used in a pure state, and copper, iron, lead, and zinc, are also very commonly so used. But gold, silver, tin, antimony, and bismuth, are, as we have shown, generally alloyed; the first three on account of their softness, and the two latter because they are extremely brittle. Gold and silver are hardened by alloying with copper; copper is hardened by zinc, tin, &c., &c.

All alloys formed of brittle metals are brittle; those made of ductile metals are in some cases ductile and in others brittle. When the proportions are nearly equal, there are as many alloys which are brittle as ductile—but when any of the metals is in excess they are most commonly ductile. In

combining ductile and brittle metals, the compounds are brittle if the brittle metal exceed, or nearly equal the proportion of the ductile one; but when the ductile metal greatly exceeds the brittle one, the alloys are usually ductile.

The *density of alloys* sometimes *exceeds*, and in other cases is *less* than that which would result from calculation. The following alloys afford examples of "*increased* and *diminished* density:"—

Increased Density.	Diminished Density.
Gold and Zinc.	Gold and Silver.
Gold and Tin.	Gold and Iron.
Gold and Bismuth.	Gold and Lead.
Gold and Antimony.	Gold and Copper.
Gold and Cobalt.	Gold and Iridium.
Silver and Tin.	Gold and Nickel.
Silver and Bismuth.	Silver and Copper.
Silver and Antimony.	Iron and Bismuth.
Silver and Zinc.	Iron and Antimony.
Silver and Lead.	Iron and Lead.
Copper and Zinc.	Tin and Lead.
Copper and Tin.	Tin and Palladium.
Copper and Palladium.	Tin and Antimony.

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Increased Density.	Diminished Density.
Copper and Bismuth.	Nickel and Arsenic.
Copper and Antimony.	Zinc and Antimony.
Lead and Bismuth.	
Lead and Antimony.	
Platina and Molybdenum.	
Palladium and Bismuth.	

Not only are the properties of metals altered by combination, but different proportions of the same metals produce very different alloys. Thus, by combining 90 parts of copper with 10 parts of tin, an alloy is obtained of greater density than the mean of the metals; and it is also harder and more fusible than the copper; it is slightly malleable when slowly cooled; but, on the contrary, when heated to red-ness and plunged into cold water, it is very malle-able. This compound is known by the name of *bronze*.

Again, as has been previously laid down, if 80 parts of copper be combined with 20 parts of tin, the compound is the extremely sonorous one, called *bell metal*.

An alloy consisting of two-thirds copper, and one-third tin, is susceptible of a very fine polish, and is used as *speculum metal*.

It is curious to observe in these alloys, that in bronze, the density and hardness of the denser and harder metal are increased, by combining with a lighter and softer one; while, as might be expected, the fusibility of the more refractory metal is in-creased by uniting with a more fusible metal. In bell metal, the copper becomes more sonorous by combination with a metal which is less so. These changes are clear indications of *chemical action*.

It has been already observed that the natural alloys, considered as such, are not important bodies. The only one, if indeed that may be reckoned so, is the alloy of iron and nickel, constituting *meteoric iron*, and of which the knives of the Esquimaux appear to be made.

The artificial metallic alloys are of the highest degree of utility. Thus, gold is too soft a metal to be used either for the purposes of coin or ornament; it is therefore alloyed with copper. Silver, though harder than gold, would also wear too quickly unless mixed with copper; and copper is improved both in hardness and colour by combination with zinc and tin, forming brass and bronze.

1853

BELLS.

THE large bells now used in churches, are said to have been invented by Paulinus, Bishop of Nola, in Campania, about the year 400: whence the "Nola" and "Campania" of the lower Latinity. They were probably introduced into England very soon after their invention. They are first mentioned by Bede, about the close of the seventh century. Ingulphus records that Turketul, Abbot of Croyland, who died about the year 890, gave a bell of a very large size to that abbey, which he named Guthlac. His successor, Egelric, cast a ring of six others, to which he gave the names of Bartholomew, Bettelin, Turketul, Tatwine, Pega, and Bega. Baronius informs us that Pope John XIII., A. D. 968, consecrated a very large new cast bell, in the Lateran Church, and gave it the name of John. The ritual for the baptizing of bells may be found in the Roman Pontificale.

The city of Nankin, in China, was anciently famous for the largeness of its bells, as we learn from Father le Compte; but they were afterwards far exceeded in size by those of the churches of Moscow.

A bell in the tower of St. Ivan's Church, in Moscow, weighed 127,836 English pounds, or 57 tons 1 cwt. 1 qr. 16 pounds. A bell given by the Czar Boris Godunof to the Cathedral of Moscow, weighed 288,000 pounds, or 128 tons 11 cwt. 1 qr. 20 lbs. And another, given by the Empress Anne, probably the largest in the known world, weighed 432,000 pounds, or 192 tons 17 cwt. 0 qrs. 26 pounds. According to Coxe (Travels in Russia, vol. 1, page 322), the height of this last bell was 19 feet, the circumference at the bottom 63 feet 11 inches, and its greatest thickness 23 inches. The great bell of St. Paul's, London, weighs 12,000 pounds, and is 9 feet in diameter.

The largest bell in England, is "Great Tom," of Christ Church, Oxford, which is 17,000 pounds weight.

ON FLUXES.

BLACK FLUX is made by mixing one part of powdered nitre with two parts of powdered *argol*, which is the commercial name for impure cream of tartar, or bitartrate of potash.

1853

TO SILVER COPPER.

PRECIPITATE silver from its nitric solution by the immersion of polished plates of copper. Take of this silver 20 grains, supertartrate of potass, 2 drachms, common salt, 2 drachms, and of alum, half a drachm. Mix the whole well together.

Then take the article to be silvered, clean it well, and rub some of the mixture, previously a little moistened, upon its surface. The silver surface may be polished with a piece of soft leather.

The dial-plates of clocks, scales of barometers, &c., are plated thus.

MOSAIC GOLD (*or molu*),

MAY be thus made: take copper and zinc, equal parts; mix them together at the lowest possible temperature at which copper will fuse, and stir until a perfect mixture of the metals is effected. Then add gradually small portions of zinc at a time, until the alloy acquires a proper colour, which is

perfectly white while in the melted state. It should then at once be cast into figured moulds. This alloy should contain from 52 to 55 per cent. of zinc.

TO BRONZE BRASS, ETC.

To 6 pounds of muriatic acid, add 2 pounds of oxide of iron, and 1 pound of yellow arsenic. Mix all well together, and let it stand for two days, frequently shaking it in the mean time, when it is fit for use.

Whatever may be the article which requires bronzing, let it be perfectly cleaned, and free from grease; immerse it in the above solution, and let it stand for three hours, or rather till it will turn entirely black. Then wash the spirits off, and dry it in sawdust, which has been found the best.

After the article is perfectly dry, apply to it some wet black, the same as used for stones, and then polish it with some dry black-lead and a brush, and it is ready for lacquering.

1853

TABLE III.—CAST IRON PIPES.

This table shows the weight of cast iron pipes 1 foot long, of bores from 1 inch to 12 inches diameter, advancing by $\frac{1}{4}$ of an inch; and of thicknesses from $\frac{1}{4}$ inch to $1\frac{1}{4}$ inch, advancing by $\frac{1}{8}$ of an inch.

Bore.	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4
In.	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*	*lbs.*
1	3.1	5.1	7.4	10.0	12.9	16.1	19.6	23.5	27.6
1 1/4	3.7	6.0	8.6	11.5	14.7	18.3	22.1	26.2	30.7
1 1/2	4.3	6.9	9.8	13.0	16.6	20.4	24.5	29.0	33.7
1 3/4	4.9	7.8	11.1	14.6	18.4	22.6	27.0	31.8	36.8
2	5.5	8.8	12.3	16.1	20.3	24.7	29.5	34.5	39.9
2 1/4	6.1	9.7	13.5	17.6	22.1	26.8	31.9	37.3	43.0
2 1/2	6.7	10.6	14.7	19.2	23.9	28.9	34.4	40.0	46.0
2 3/4	7.4	11.5	16.0	20.7	25.7	31.1	36.8	42.8	49.1
3	8.0	12.4	17.2	22.2	27.6	33.3	39.3	45.6	52.2
3 1/4	8.6	13.3	18.4	23.8	29.5	35.4	41.7	48.3	55.2
3 1/2	9.2	14.2	19.6	25.3	31.3	37.6	44.2	51.1	58.3
3 3/4	9.8	15.2	20.9	26.9	33.1	39.7	46.6	53.8	61.4
4	10.4	16.1	22.1	28.4	35.0	41.9	49.1	56.6	64.4
4 1/4	11.1	17.1	23.4	30.0	36.9	44.1	51.6	59.4	67.6
4 1/2	11.7	18.0	24.5	31.4	38.7	46.2	54.0	62.1	70.6
4 3/4	12.3	18.9	25.8	33.0	40.5	48.3	56.5	64.9	73.6
5	12.9	19.8	27.0	34.5	42.3	50.5	58.9	67.6	76.7
5 1/4	13.5	20.7	28.2	36.1	44.2	52.6	61.4	70.4	79.8
5 1/2	14.1	21.6	29.5	37.6	46.0	54.8	63.8	73.2	82.8
5 3/4	14.7	22.6	30.7	39.1	47.9	56.9	66.3	76.0	85.9
6	15.3	23.5	31.9	40.7	49.7	59.1	68.7	78.7	88.8
6 1/4	16.0	24.4	33.1	42.2	51.5	61.2	71.2	81.2	92.0
6 1/2	16.6	25.3	34.4	43.7	53.4	63.4	73.4	84.2	95.1
6 3/4	17.2	26.2	35.6	45.3	55.2	65.3	76.1	87.0	98.2
7	17.8	27.2	36.8	46.8	56.8	67.7	78.5	89.7	101.2
7 1/4	18.4	28.1	38.1	48.1	58.9	69.8	81.0	92.5	104.3
7 1/2	19.0	29.0	39.1	49.9	60.7	72.0	83.5	95.3	107.4
7 3/4	19.6	29.7	40.5	51.4	62.6	74.1	85.9	98.0	110.5
8	20.0	30.8	41.7	52.9	64.4	76.2	88.4	100.8	113.5
8 1/4	20.9	31.7	43.0	54.5	66.3	78.4	90.8	103.5	116.6
8 1/2	21.7	32.9	44.4	56.2	68.3	80.8	93.5	106.5	119.9
8 3/4	22.1	33.6	45.4	57.5	70.0	82.7	95.7	109.1	122.7
9	22.7	34.5	46.6	59.1	71.8	84.8	98.2	111.8	125.8
9 1/4	23.3	35.4	47.9	60.6	73.6	87.0	100.6	114.6	128.9
9 1/2	23.9	36.4	49.1	62.1	75.5	89.1	103.1	117.4	131.9
9 3/4	21.6	37.3	50.3	63.7	77.3	91.3	105.5	120.1	135.0
10	25.2	38.2	51.5	65.2	79.2	93.4	108.0	122.8	138.1
10 1/4	25.8	39.1	52.8	66.7	81.0	95.6	110.4	125.6	141.1
10 1/2	26.4	40.0	54.0	68.3	82.8	97.7	112.9	128.4	144.2
10 3/4	27.0	41.0	55.2	69.8	84.7	99.9	115.4	131.2	147.3
11	27.6	41.9	56.5	71.3	86.5	102.0	117.8	133.9	150.3
11 1/4	28.2	42.8	57.7	72.9	88.4	104.2	120.3	136.7	153.4
11 1/2	28.8	43.7	58.9	74.4	90.2	106.3	122.7	139.4	156.4
11 3/4	29.5	44.6	60.1	75.9	92.0	108.5	125.2	142.2	159.5
12	30.1	45.6	61.4	77.5	93.6	110.6	127.6	145.0	162.6

TABLE IV.—CAST METAL CYLINDERS.*

Diam.—*Ins.*	Iron.—*lbs.*	Copper.—*lbs.*	Brass.—*lbs.*	Lead.—*lbs.*
1	2.5	3.0	2.9	3.9
2	9.8	12.0	11.4	15.5
3	22.1	27.0	25.8	34.8
4	39.3	47.9	45.8	61.9
5	61.4	74.9	71.6	96.7
6	88.4	107.8	103.0	139.3
7	120.3	146.8	140.2	189.6
8	157.1	191.7	183.2	247.7
9	198.8	242.7	231.8	313.4
10	245.4	299.5	286.2	387.0

TABLE V.—SPECIFIC GRAVITY AND WEIGHT OF MATERIALS.

METALS.	Specific Gravity.	Wt. of 1 cubic foot.	Wt. of 1 cubic inch.
	oz.	*lbs.*	*oz.*
Antimony, cast	6702	418.9	3.878
Arsenic	5763	360.2	3.335
Bismuth, cast	9822	613.9	5.684
Brass, cast	8396	524.8	4.859
Brass, wire	8544	534.0	4.944
Bronze	8222	513.4	4.753
Cobalt, cast	7811	488.2	4.520
Copper, cast	8788	549.3	5.086
Copper, sheet	8915	557.2	5.159
Copper, wire	8878	554.9	5.136
Gold, pure	19258	1203.6	11.161
Gold, hammered	19362	1210.1	11.205
Gold, standard	17647	1102.9	10.230
Gun metal	8784	549.0	5.083
Iron, bars wrought	7786	486.6	4.506
Iron, cast	7207	450.4	4.171
Lead, cast	11352	709.5	6.569
Mercury, solid	15632	977.0	9.046
Mercury, fluid	13568	848.0	7.852
Nickel, cast	7807	487.9	4.518
Platinum, pure	19500	1218.8	11.285
Platinum, hammered	20336	1271.0	11.767
Silver, pure	10474	654.6	6.061
Silver, hammered	10511	656.9	6.083
Silver, standard	10534	658.4	6.096
Steel, tempered	7818	488.6	4.524
Steel, soft	7833	489.6	4.533
Tin, cast	7291	455.7	4.244
Type metal	10450	653.1	6.047
Zinc, cast	7190	449.4	4.161

* The cylinders are solid, each one foot in length.