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THIRD EDITION.

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PRACTICAL

DENTAL METALLURGY.

BY

THOMAS FLETCHER, F.C.S.,

WARRINGTON.

PRINTED AND PUBLISHED BY

MACKIE AND CO., LIMITED,

WARRINGTON.

1890.

PREFACE TO THE THIRD EDITION.

The two previous editions were both exhausted in a few months, and as the enquiries for copies are still continuous I have decided to again reprint the work, without any alterations except a few minor corrections.

This book is a collection of odd working notes put together for my own covenience and reference. To these I have added such information as I am frequently asked for in private letters, and which I have not time to reply fully to in each case. It is both incomplete and imperfect when considered as a class or text book, and is designed only to be useful for dentists in practice. To write a complete and exhaustive text book on this subject would be a labour far greater than my present engagements would permit me to undertake.

THOS. FLETCHER.

CONTENTS.

Newtons Metal 45

PRACTICAL
DENTAL METALLURGY.

EXPLANATION OF TERMS USED.

ALL temperatures, unless otherwise specified, are given Centigrade. As many readers will probably have a limited chemical knowledge, the following explanations may be useful.

ATOMIC WEIGHTS.

These are the proportions by weight in which one substance or element replaces another in a combination.

All the elements replace each other in combinations in precisely the same manner and in invariable proportions. Sometimes a substance will combine with another in two or more different proportions, these being always multiples of each other.

WATER OF CRYSTALLIZATION.

The weight of any salt or combination of a metal does not always give simply the proportions of the elements contained, as frequently there is also water in combination. This, as water of crystallization, is always the same for the same compound, and when once known can be allowed for.

SPECIFIC HEAT.

The heat which diffuses itself through substances accumulates in them in quantities which differ according to their peculiar nature, not depending on either weight or volume. Different bodies require different quantities of heat to raise their temperature equally, and disengage different quantities of heat in cooling through same number of degrees of temperature. The different capacity of bodies for heat is called specific heat when bodies are compared with regard to their weight. Equal weights of bodies heated to an equal temperature, but having different specific heats, raise the temperature of a given quantity of water through a different number of degrees. Thus, the specific heat of zinc being 0·0927 and lead 0·0293 accounts for the fact that zinc requires so much longer to melt than would be expected, judging from the comparatively small difference in the melting points of the two metals. It also accounts for the fact that a much larger quantity of cold water is required to cool a zinc die than a lead reverse of the same weight, the total quantity of heat taken up and rendered latent or inappreciable to a thermometer being much greater than is the case with lead, this heat again making its appearance and proving its presence by a greater quantity of water heated by the zinc in cooling.

The specific heat of a metal may be an important consideration to the dentist in many cases: for instance, the high specific heat of palladium, combined with its low conducting power, prevents the sudden chill felt with a gold plate in the mouth on drinking a cold liquid, and also in a similar manner assists in preventing scalding with hot liquids. This is one of the reasons why palladium is unequalled by any metal for artificial dentures.

SYMBOLS.

These are the short forms by which the substances are denoted in chemical compounds, and are used for simplicity and convenience in all chemical works.

Name.	Symbol.	Atomic weight.	Melting point, centigrade.	Specific gravity.	Specific heat.	Boiling point.	Tenacity in lbs., sq. in.	Resistance to crushing in lbs., sq. in.
			Degs.			Degs.		
Hydrogen	H	1						
Oxygen	O	15·96						
				water= 1·0000				
Aluminium ...	Al.	27·3	700	2·6000				
Antimony	Sb.	122	425	6·7010	0·050		1066	
Bismuth	Bi.	210	265	9·8220	0·029		3250	
Zinc	Zn.	64·9	411	6·9154	0·092	1040	8000	
Cadmium	Cd.	111·6	320	8·6355	0·038	860		
Tin...............	Sn.	117·8	228	7·2900	0·051		5000	15000
Lead	Pb.	206·4	334	11·3839	0·030	1040	1824	7000
Pure Iron	Fe.	55·9	1600	7·8439	0·110		60000	38000
Nickel	Ni.	58·6	1600	8·6370	0·108			
Copper	Cu.	63	1173	8·7210	0·095		cast 19072	11700
Mercury	Hg.	199·8		13·559	0·032	350		
Silver............	Ag.	107·66	1023	10·4280	0·056		41000	
Gold	Au.	196·2	1102	19·5000	0·028		20400	
Palladium	Pd.	106·2		11·5000	0·059			
Platinum	Pt.	196·7	2534	21·5000	0·031			
Cast Brass......							17978	10300
Brass Wire ...							49000	
Cast Iron							19000	92000
Steel							120000	

NOTE.—The melting points of metals as given in figures are never perfectly reliable. The most modern authorities differ considerably, and the degrees as given must be only taken as an approximation.

COMPARISON BETWEEN THE CENTIGRADE AND FAHRENHEIT THERMOMETER SCALES.

Centigrade.	Fahrenheit.	Centigrade.	Fahrenheit.
Degrees.	Degrees.	Degrees.	Degrees.
260	500	130	266
255	491	125	257
250	482	120	248
245	473	115	239
240	464	110	230
235	455	105	221
230	446	100	212
225	437	95	203
220	428	90	194
215	419	85	185
210	410	80	176
205	401	75	167
200	392	70	158
195	383	65	149
190	374	60	140
185	365	55	131
180	356	50	122
175	347	45	113
170	338	40	104
165	329	35	95
163	325·4	30	86
160	320	25	77
157	314·6	20	68
155	311	15	59
150	302	10	50
145	293	5	41
140	284	0	32
135	275		

A ROUGH METHOD OF ESTIMATING HIGH TEMPERATURES.

Degrees Centigrade.	
411	Zinc melts.
525	Slight glow in the dark.
700	Dark red.
900	Cherry red.
1000	Bright cherry red.
1023	Fine silver melts.
1150	Orange.
1102	Fine gold melts—(1250° Bayley).
1173	Fine copper melts—(1050° ,,).
1300	White.
1350	Steel melts.
1500	Dazzling white.
1600	Wrought iron melts.
2534	Platinum melts.

BEHAVIOUR OF METALS WITH ACIDS.

Not attacked by dilute sulphuric acid at ordinary temperatures.

Gold, Platinum, Antimony, Lead (Copper very slightly), Mercury, Silver, Bismuth, Tin (Palladium slightly attacked).

Soluble in dilute sulphuric acid.

Iron, Zinc, Cadmium, Aluminium, Nickel (Tin with the assistance of heat).

Not attacked by dilute nitric acid.

Gold, Platinum, Aluminium, Palladium.

Soluble in dilute nitric acid.

Lead, Cadmium, Iron, Copper, Nickel, Mercury, Silver, Bismuth, Zinc. Antimony and Tin are oxydized but not dissolved.

Not attacked by hydrochloric acid.

Antimony, Gold (Copper if air is excluded), Mercury, Platinum.

Slightly attacked.

Lead, Palladium, Silver, Bismuth.

Soluble in hydrochloric acid.

Aluminium, Cadmium, Iron, Nickel, Zinc, Tin.

Soluble in solutions of soda and potash.

Aluminium, Zinc (Tin when heated).

Attacked by fused alkalis at high temperatures.

Platinum, Palladium.

BEHAVIOUR OF SOLUTIONS OF METALS WITH COMMON REAGENTS.

Metal.	Caustic potash.	Carbonate of Potash.	Ammonia.	Carbonate of ammonia.	Sulphuretted hydrogen.
Zinc	W	W	W	W	No precipitate
Nickel.........	G	G		G x	„ if acid
Aluminium ...	W x	W	W	W	„
Arsenic					Y
Antimony ...	W x	W	W	W	O
Tin	W x		W x	W	B r
Cadmium ...	W	W	W x	W	Y
Copper	Bl	G Bl	G Bl x	G Bl x	B B
Bismuth	W	W	W	W	B B
Lead	W x	W	W x	W	B
Silver	Br	W	Br x		B

Explanation :—x, Precipitate soluble in excess of reagent; W, white; G, green; Y, yellow; O, orange; Br, brown; Bl, blue; B B, brownish black; B, black.

BEHAVIOUR OF METALS BEFORE THE BLOWPIPE, ON CHARCOAL, WHEN HEATED BY THE REDUCING FLAME *(in the blue cone).*

Leave an infusible white residue.

Aluminium, Zinc. If moistened by cobalt nitrate and again heated, Aluminium becomes blue, Zinc green.

Form an incrustation on the charcoal.

White, garlic odour, distant from flame—Arsenic.
White, nearer to flame—Antimony.
Yellow when hot, white when cold—Zinc.

Faint yellow when hot, white when cold, near to the flame—Tin.

Yellow—Lead.

Dark orange yellow when hot, lemon yellow when cold—Bismuth.

Brownish red or yellow—Cadmium.

Dark red, very slight—Silver.

BEHAVIOUR OF METALS IN AIR.

Metals.	At ordinary temperatures. Dry air.	At ordinary temperatures. Moist air.	At high temperatures.
Aluminium ...	No change	Slowly tarnishes	Burns, forming $Al^2 O^3$
Bismuth	No change	Slowly tarnishes	Burns to $Bi^2 O^3$
Cadmium	No change in air free from carbonic acid	No change in air free from carbonic acid	Burns to Cd O
Copper	No change	Tarnishes	Burns to Cu O
Gold	No change	No change	No change
Platinum	No change	No change	No change
Palladium	No change	No change	Oxydizes at low red. Oxide is reduced again at higher temperatures
Lead	Tarnishes	Tarnishes	Burns to Pb O
Mercury	No change	Slowly tarnishes	Burns to Hg O
Nickel	No change	No change	Forms Ni O
Silver	Blackened if sulphuretted hydrogen is present	Blackened if sulphuretted hydrogen is present	No change
Tin	No change	No change	Forms $Sn O^2$
Zinc	Tarnishes	Tarnishes	Burns to Zn O

ALLOYS.

GENERAL PROPERTIES.

Most metals combine in the proportions of their atomic weights, or in multiples of these, forming what may in many cases be considered feeble chemical combinations. The resulting alloy is frequently different in specific gravity to the calculated mean; the combination takes place in some cases with the evolution of intense heat (Platinum and Tin as an example), and, where two metals only are in combination, such as copper and mercury, or palladium and mercury, there is no doubt that these are best when the relation to the atomic weights is strictly observed. When, however, we get alloys with three or more metals, such as tin, silver, mercury, &c., all my experience goes to prove that the atomic proportions form mixtures which apparently are never at rest; there are constant internal changes and apparently sub-alloys forming, which make the result, so far as dentists are concerned, anything but desirable, as these changes frequently show themselves by continued changes in form, extending over months or years.

In compound alloys it is, therefore, necessary not to use any of the metals in their atomic proportions to each other and to make the alloy in such a manner that the separation of sub-alloys is, as far as possible, prevented.

Experience and the knowledge of the practical manipulation of certain alloys will do much to prevent these forming in the fused mixture, but no amount of skill will entirely prevent them. It is, therefore, necessary to test every ingot of every compound alloy for all properties required before permitting it to be used. An experience of many years, with every possible appliance for precision in working, only goes to prove that failures in producing a uniform alloy are frequent, and testing every ingot is an absolute and unavoidable necessity if uniform results are to be obtained.

In alloys where mercury is not a component part the differences between 2 ingots or between 2 parts of the same ingot are of small practical importance, although they still exist in almost every alloy made, notably so in the silver coinage. It is no unusual case for the two opposite edges of a shilling or florin to give different results on assaying, although the alloys are made with every possible care and precaution.

CONTRACTION OF CASTINGS IN COOLING—

i.e., the amount of difference between the size of the impression in sand and the casting produced.

Cast iron	·125
Copper	·193
Brass...	·210
Lead...	·319
Tin	·278

The superiority of iron castings for exact work in making dies is clearly demonstrated by the above, irrespective of the fact that one die will do all necessary in a far superior manner to a die made with any other metal. Iron runs perfectly in open sand in the usual manner of casting dentists' dies. A little sawdust or charcoal powder should be sprinkled over the surface of the metal in the crucible.

TENACITY OF METALS.

A wire of the same diameter will support the following comparative weights without breaking:—

Iron	549	lbs.
Copper	302	,,
Platinum	274	,,
Silver...	187	,,
Gold	150	,,
Zinc	109	,,
Tin	39	,,
Lead	27	,,

POWER OF CONDUCTING HEAT.

Gold 53, Platinum 8, Silver 100, Copper 74, Iron 12, Zinc 36, Tin 14, Lead 9, Brass 24, Bismuth 2.

DILATION BY HEAT.

			Expansion between the freezing and boiling point of water.
Platinum	expands	1 in	1097
Palladium	,,	,, ...	1000
Antimony	,,	,, ...	923
Iron (cast)	,,	,, ...	901
Gold	,,	,, ...	667
Copper	,,	,, ...	557
Brass	,,	,, ...	524
Silver	,,	,, ...	499
Tin	,,	,, ...	424
Lead	,,	,, ...	350
Zinc	,,	,, ...	336

The contraction in cooling from castings corresponds to the above; the contraction of zinc being the greatest, nearly 3 times that of cast iron.

APPARATUS.

The chemical portion of this book does not go into the matter of quantitative analysis. For this work more time and more apparatus are necessary than are available by a dentist in ordinary practice. For the detection of certain metals the processes are given when moderately simple; in other cases it will be better to put the matter in the hands of a qualified chemist.

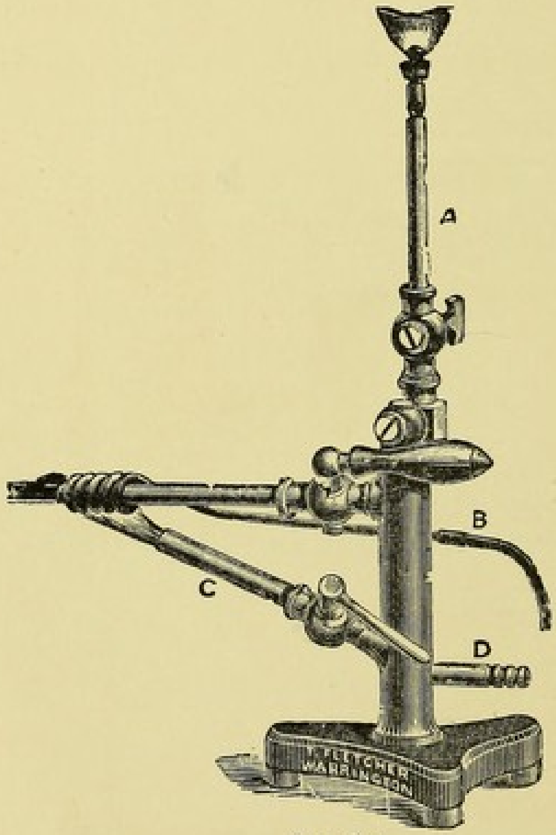
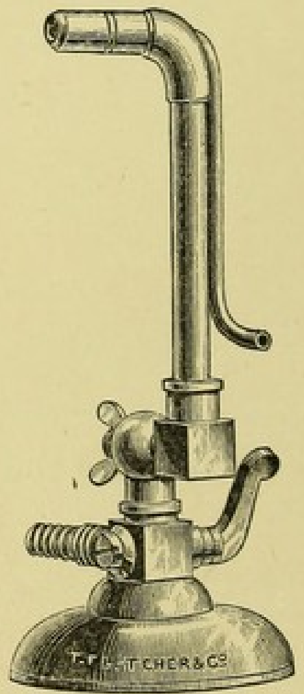


FIG. 1 B.



JEWELLERS' PATTERN.

WHERE A SUBLIMATE IS TO BE OBTAINED ON CHARCOAL the only charcoal which does not give a coloured ash, and so interfere with the result, is that made from pitch pine. This is not to be obtained commercially in England; in fact, the only place I know it is to be obtained is from the laboratory man at the Freiberg School of Mines. It is better to dispense with charcoal slabs and use aluminium plate instead, on which sublimates are more visible and more easily recognized. The work of Lieut.-Col. Ross gives full instructions for the use of this. Sublimates may also be obtained on a blackened slip of fireclay.

THE BEST BLOWPIPE for analysis is one of the two engraved on previous page. The jet must be of very fine bore and in good condition, so as to give a clearly defined and sharply pointed blue cone. For soldering a much larger jet is required.

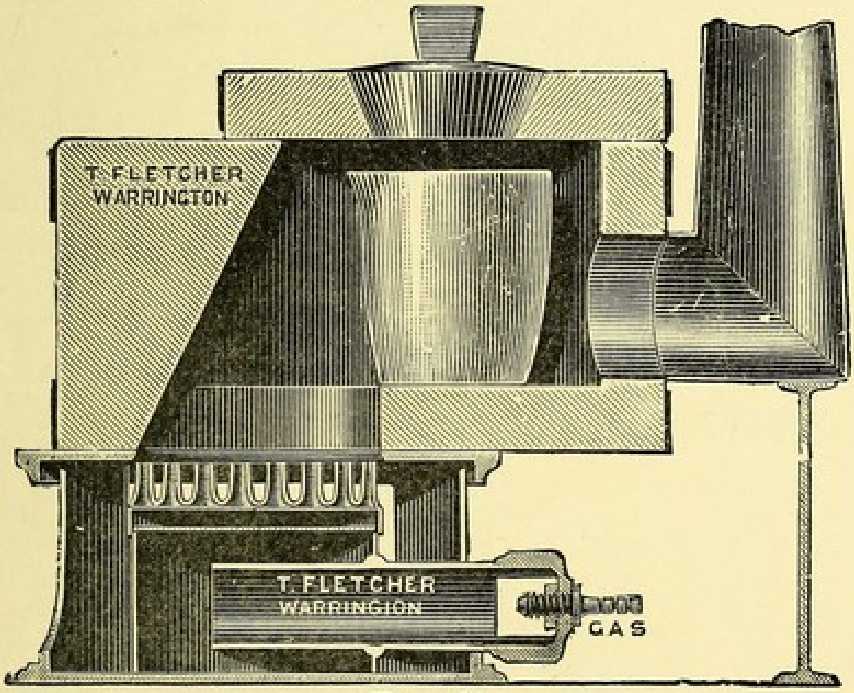


FIG. 63.

FOR ROASTING OR OXYDIZING, and also for melting metals in crucibles at temperatures not exceeding the fusing point of fine silver, the gas furnace, Fig. 63, is all that could be desired. Roasting and cupelling may also be done in the muffle furnace, Fig. 61, provided a slit is cut in the back of the muffle so as to allow a current of air to pass through.

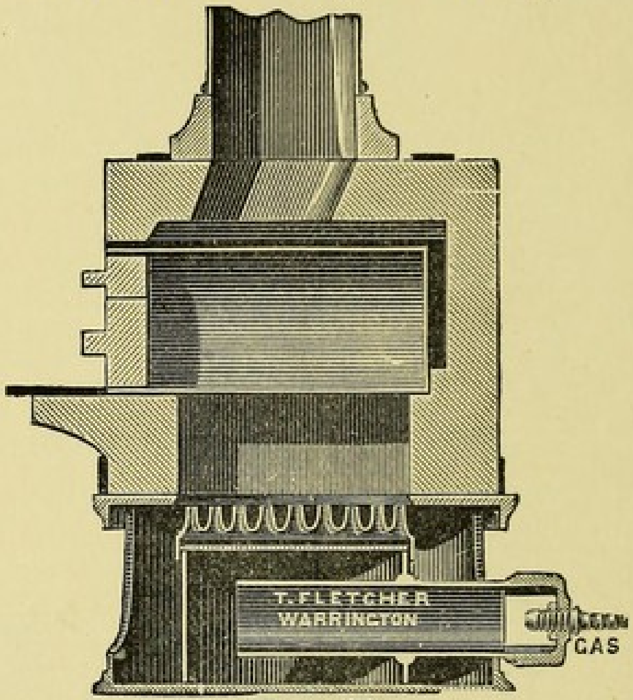


Fig. 61.

For the Fusion of all Metals in Crucibles, and more especially for those metals fusing at high temperatures, the injector furnace, Fig. 41, is the simplest and most powerful. This requires a blast of air from a good foot blower.

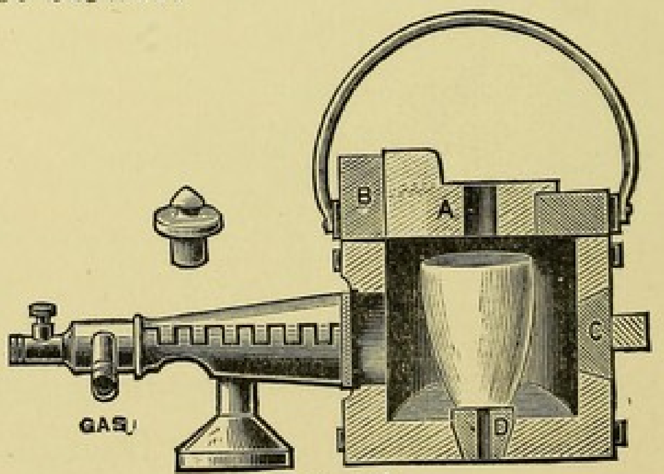
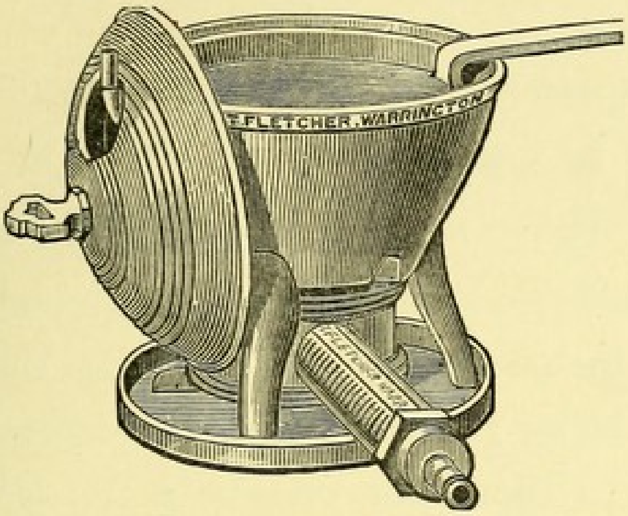


Fig. 41.

For Melting Metals at Temperatures below Redness the ladle furnace is the simplest and readiest apparatus.



For Drying, Evaporating, &c., the laboratory burner here illustrated is the most useful form. The cylinder can be removed and the burner used with cover of a plate dryer, which arrangement will enable the user to heat blocks of ½lb. weight to redness. With the cylinder the lowest temperatures can be obtained, and either flat or round bottom vessels are held securely. The sand bath can be used without the cylinder for high or with it for low temperatures.

Apparatus more especially designed for dental laboratories will be found in the advertisements.

Where Gas is not Obtainable a lamp burning solid paraffin is the most satisfactory for blowpipe analysis.

For soldering, the cleanest method, in the absence of gas, is to use a spirit lamp with a wick about three-eighths of an inch wide, and one inch long. This when properly used, gives a powerful flame, well under control. The spirit holder should be at a few inches distance from the wick holder, and the connection made between the two with a tube.

SEFTSTROM'S CHARCOAL FURNACE.

A Charcoal or Coke Furnace in which refractory metals can be fused rapidly and almost as easily as in a gas furnace can be made as follows:—

Make a double sheet iron box, the inner box being about 12 inches square and open at the top, the outer one being about 3 inches larger each way and connected to the inner one by a flange round the top so as to be air-tight. The outer box has an inlet for air from a blower: the inner one has six or eight half-inch holes punched through the sides about four inches from the bottom, and is lined with slabs of fireclay having holes corresponding to these. When in use, the top should be partially covered with a slab of fireclay. The blast enters the hole in the outer casing, and passes through the holes in the inner casing, to the fuel. The crucible must be supported on a block about 3 inches high. With this furnace, using charcoal as a fuel, and a good blower, cast iron or steel can be perfectly melted in about 10 minutes after the fire is lighted. This furnace, which is known as Seftstrom's, can be purchased from any dealer in chemical apparatus. A good draught furnace for general use can be made in an ordinary fireplace by removing the grate and building a square box of firebrick with an iron grate at the bottom: the box does not need to be over 9 inches square and the same height; the front above the furnace must be left open, and closed when the furnace is in use by a plate of iron with a handle for lifting away. It is better to fit a door also to the ashpit with a hole about 2 inches diameter having a tube fitted in and projecting 2 or 3 inches, to which a fan can be connected, or into the centre of which a jet of air from a footblower can be directed to urge the draught when required.

In building any furnace of firebrick or slabs, fireclay must be used as a cement instead of mortar, and the fireclay must be mixed, not with water, as is usual, but with a solution of silicate of soda, which can be readily and cheaply obtained in almost any part of the world. Joints made in this manner will bear firing immediately they are made, and will stand rough use with ladles, &c., under circumstances where a furnace built with fireclay cement alone would rapidly be broken up.

A furnace of this kind is readily adapted to muffles for continuous gum, crucibles, ladles, and all the work necessary in the laboratory, and when not required can be quickly extinguished by closing the hole in the ashpit door by a cap. If required for muffles a ledge should be left at the back about 5 inches above the top of the firebox, to carry the muffle, and the front will require to be built up, leaving a hole with door about 9 inches above the top of the muffle to enable fresh fuel to be added as required. If the shaft is 9 inches wide clear inside the muffle should not exceed $4\frac{1}{2}$ inches, as room is required on each side to allow the fuel to fall down at the sides of the muffle. If no blower is used a chimney of at least 20ft. high should be allowed for continuous gum work, but a modification of Seftstrom's furnace can be built giving ample heat and requiring no chimney.

As a fuel Durham coke (not gas coke) will be found to fulfil every requirement, although charcoal, when not too costly, is to be preferred for quick work and high temperatures.

PETROLEUM VAPOUR BLAST.

A very small quantity of the vapour of the lighter petroleums mixed with the air which is blown into a blast furnace burning solid fuel reduces the consumption of fuel and lessens the trouble of falling fuel and disturbance of crucibles. It also increases the heat enormously, if not in too great quantity. The peculiar roar caused by this addition to the air is readily recognized, and disappears when the vapour is in excess. The simplest way to apply it is to allow a slow drip of benzoline or gasoline into the fan chamber or into the air pipe from the blower; other things being equal, this simple addition doubles the power of any furnace. It is probable that a drip into the ashpit of a draught furnace might also have the same effect, but I have had no experience with this, having discarded solid fuel entirely for many years. In an ordinary laboratory where gas is not available the work is increased fully 50 per cent., and in some classes of work is more than doubled. It is, therefore, not advisable to use solid fuel where gas or gasoline is available.

Firebricks.—Where not exposed to mechanical injury a mixture of one part by bulk of dry fireclay with 3 or 4 parts of sawdust, moistened, worked into form and burnt, enables very much higher temperatures to be obtained in a furnace than can be obtained with ordinary firebricks. This mixture is used for the casings of the well-known injector furnace, and is one of the most important points in its construction. The use of simple fireclay instead of this mixture would reduce the power of the injector furnace to about one half, and would render it totally useless for many most important operations. When temporary experiments are to be made quickly, casings of this mixture may be used with perfect success without burning in a kiln, and with careful handling they stand fairly well in daily use. Nickel melters almost invariably use the casings simply dried in a warm place without firing before they are used.

EXAMINATION OF METALS ON CHARCOAL WITH THE BLOWPIPE.

The blowpipe used must give a steady and clearly defined blue cone. Beyond the point of this cone and at as long a distance from it as the heat can be obtained, is the oxydizing flame, afterwards denoted by O.F. Inside the blue cone is the reducing flame, afterwards denoted by R.F. The sample to be submitted to this must be small enough to be entirely surrounded by flame and perfectly protected thereby from the action of the external air.

When charcoal is used, the ash formed by its combustion must not be mistaken for a sublimate or coating produced by the substance in the flame, and by a preliminary experiment the colour of the charcoal ash must be perfectly known so as to prevent risk of errors.

The appearance of some metals not of use to dentists is given to prevent possible mistakes. When metals are in an alloy the distinctive marks are usually fainter than when the pure metal is tested.

ARSENIC volatilizes without fusing, and coats the coal with arsenious acid in both flames; the white coat appears greyish when thin, and is at a distance from the assay. It can be driven off by simply warming with the flame, and if rapidly treated by the R. F. colours it a pale blue. It evolves when heated an odour of garlic.

ANTIMONY melts easily, coating the coal with oxide in both flames. The white coat, bluish in thin layers, is not so distant as with arsenic. It can be driven about by heating gently with the O. F., and disappears in the R. F., tinging it a pale green. When melted and heated to redness it remains melted and glowing for some time, evolving dense white fumes, which condense partly on the coal and finally surround the button with white pearly crystals.

LEAD coats the coal with oxide in both flames. When warm this is dark lemon yellow; when cold, sulphur yellow, and bluish white in thin layers. When the coal is heated to glowing the coat changes its place, and the flame is at the same time coloured blue.

BISMUTH gives a coat of oxide dark orange yellow when hot, lemon yellow when cold, and nearly white in very thin layers. It can be driven about on the glowing coal like lead, but does not colour the R. F. like lead.

CADMIUM melts easily and burns in the O. F. with a dark yellow flame and brown fumes, coating the coal with oxide rather near the assay. Nearest the assay the coat is thick, crystalline, and very dark, nearly black. Further off it is reddish brown, and in very thin layers orange yellow. It can easily be reduced and driven about with either flame, but gives no colour. Beyond the furthest limits of the coat the coal sometimes shows a variegated tarnish.

ZINC fuses easily and burns in the O. F. with a strongly luminous greenish white flame, and dense white fumes which coat the coal with oxide. The coat is rather near the assay, yellow whilst hot, white when cold. It becomes luminous under the O.F., but is not volatilized. It is very slowly volatilized by the R. F.

TIN in the O. F. is covered with oxide which can be blown away. In the R. F. the metal becomes clear and coats the coal with oxide, which is pale yellow whilst warm and luminous under the O. F. On cooling it becomes white. It is so close to the assay that it borders directly on it, and cannot be volatilized. It is slowly reduced to metallic tin by the R. F.

SILVER fused for some time with a powerful oxydizing flame gives a slight reddish brown coat of oxide. If combined with a little lead a coat of yellow oxide of lead forms. With antimony present a white coat forms, which becomes red on continued blowing. If it contains both a crimson coat forms.

PLATINUM AND PALLADIUM give no reaction.

GOLD.

Specific Gravity, 19·5	*Symbol*, Au.
Specific Heat, 0·028	*Atomic Weight*, 196·2
Tenacity in lbs., sq.in., 20,400	*Melting point*, 1102° C.

Found native.

PURIFICATION FOR DENTAL PURPOSES.—Dissolve in nitro-muriatic acid, precipitate by sulphate of iron, and fuse the precipitate with borax and a small quantity of nitrate of potash.

Gold is also refined on a large scale by passing chlorine gas through it whilst in a state of fusion. It may also be purified by melting with lead and cupelling on bone earth in the same manner as silver; this, however, does not remove all the other metals present.

The clean surfaces of absolutely pure gold will weld without the aid of heat, and if the welding property is destroyed by accidental moisture or impurities, it can be restored partially without the aid of heat by washing the surface with chloroform.

CRYSTAL GOLD is prepared by slowly heating an amalgam of gold in a muffle until the whole of the mercury is driven off. If a very light spongy mass is required the first part of the mercury may be removed by pure nitric acid without the assistance of heat, which would fuse an amalgam having a large proportion of mercury. An amalgam of 6 mercury and 1 gold crystallizes in four-sided prisms; the whole of the mercury can be driven off from this by heat, leaving the gold in a light spongy mass.

GOLD AND SILVER combine in all proportions, forming a soft ductile alloy of greenish colour when the silver is in large proportion.

Gold 22, silver 1, copper 1, forms a hard alloy, having a specific gravity of 17·344.

GOLD IN AMALGAMS renders them cleaner and pleasanter to use, but reduces the power of setting, thereby also probably reducing the shrinkage of amalgams which have this fault.

THE ENGLISH SOVEREIGN weighs 123¼ grains, and contains 113 grains pure gold.

To reduce sovereigns from 22 carats to lower standards add for each coin—

For	16	carat	46	grains	alloy.
,,	18	,,	27½	,,	,,
,,	20	,,	12½	,,	,,

HARD SPRINGY GOLD, *16 carat:—*

Gold 36, silver 6, copper 12.

Gold Solders—

For 22 carat—take 22 carat gold 24 parts, silver 2, copper 1.

For 18 carat—take 18 carat gold 24 parts, silver 2, copper 1.

For 16 carat—take 16 carat gold 24 parts, silver 8, copper 6.

Brass is generally used, *i.e.* the alloy of 7 copper, 3 zinc, in preference to copper for all gold solders. The presence of a trace of zinc causes the solder to flow much more freely. It may be taken as a general rule that the use of zinc in a gold solder is not acknowledged, and yet, curiously enough, the zinc is to be found in nearly if not all good solders. The following 3 formulas are taken from Oakley Cole's "Manual of Dental Mechanics."

16 carat solder for 18 or 20 carat plate:—Fine gold 6, copper 2, fine silver 1 *(the previous remarks as to brass will also apply to this).*

15 carat solder.—Gold coin 144, silver 30, copper 20, brass 10.

(It is not stated if silver coin is to be used or fine silver.)

18 carat solder.—Gold coin 30, silver 4, copper 1, brass 1.

Some dentists who make their own solder simply add.1 part of zinc to 12 parts of the gold for which the solder is required.

It may be taken as a rule that ordinary fine silver and fine gold should never be used for alloying. They are frequently sufficiently impure to be utterly unfit for any of the requirements of the dentist, containing metals in small quantities *(such as lead)* which spoil the alloy and make it brittle. It is much safer always to take coins, as the fact that the coin has been rolled from the ingot and stood the blow of the dies is always a proof that the metal can be trusted not to produce a brittle ingot. Many samples of gold almost chemically pure are quite unworkable. Before the process of refining by chlorine gas was discovered this fact caused very serious difficulties and losses at the English mint.

FALSE COINAGE.—In melting sovereigns care is requisite in examining each coin. A very large number of splendid imitations are made of platinum heavily gilt. I have had large quantities of these, purchased along with platinum scrap, and so long as the gilding is perfect they can only be detected with the greatest difficulty.

An alloy of 16 platinum, 7 copper, 1 zinc also makes imitations of gold coinage so perfect as to be beyond ordinary detection. The falsification of gold coinage is not confined to English coins, but is, if anything, more frequent with French, Spanish, and American coinage.

A PASTY ALLOY OF GOLD AND MERCURY is used for heavy gilding, the mercury being driven off by heat.

ASSAY OF GOLD.

The exact assay of gold is beyond the province of the dentist, but a very close approximation may be got by taking any known and convenient quantity, say, for the convenience of calculation, 10 or 25 grains, melting with it 4 or 5 times its weight of silver, rolling into an extremely thin sheet, curling this up into an open spiral (technically called a cornet), and boiling in a glass vessel with strong pure nitric acid for 15 or 20 minutes. The acid must then be carefully washed away, fresh acid added, and the boiling again carried on for the same time. The result when washed and dried consists of the fine gold contained in the sample along with any platinum if present. It can be melted up again with borax, and the silver can be precipitated from the acid by salt as chloride and reduced to metallic state (see silver) if desirable. Zinc is sometimes used in the place of silver for this process.

It must be borne in mind that this process will not succeed unless a large proportion of silver—at least 4 times the weight of the gold—is used, as when the surface silver is dissolved out the gold must be sufficiently open and porous to allow the acid free access to the centre; otherwise some silver is left undissolved, and the result is not correct.

When platinum is present in objectionable quantities it can be separated by rolling the sample of gold (without melting with silver) very thin, dissolving it in about 4 times its weight of nitro-muriatic acid (which should be mixed when wanted in the proportions of 1 Nitric acid to $2\frac{1}{2}$ Hydrochloric acid), and the solution is assisted by a little heat. The silver present falls as insoluble chloride, which must be separated by decanting and washing, adding the washings to the gold solution. Evaporate this to nearly dryness, add a little hydrochloric acid, and again evaporate so as to get rid of the nitric acid.

Dilute largely with water and add slowly a solution of proto-sulphate of iron until a precipitate ceases to form. Wash this precipitate with sulphuric acid to remove all traces of iron, then wash repeatedly with hot water, dry, and melt with borax in a crucible.

The platinum may now be separated from the solution, if necessary, by adding a solution of muriate of ammonia. These processes, although sufficiently correct for any purpose required by a dentist, are not absolutely correct; greater care is required in many points for an exact assay.

A ROUGH AND PERFECTLY SATISFACTORY WAY OF REDUCING DIRTY FILINGS AND WASTE to good working gold is to boil it in a cast iron enamelled cup with about 3 times its weight of strong nitric acid, to near dryness, adding a little more acid—say about one-third the quantity first used, and boiling down again. The residue must now be washed with hot water, and what remains after washing melted with borax in a crucible. This gives a gold about equal in quality to the bulk from which the filings were made, and is both simple and certain in the results.

COLOURING GOLD.

A thick pasty solution of a mixture of nitrate of potash, sulphate of iron and common salt is used for extracting the alloy from the face of gold. It is generally used boiling hot, in a crucible, and the finished work dipped into it. When sufficiently coloured the adhering mixture is washed off with boiling water. This process requires some little practice to prevent streaks and irregular colouring, and a good quality of solder must be used, or it is liable to be blackened and the joints made weak.

SILVER.

Specific Gravity, 10·5 *Symbol*, Ag.
Specific Heat, 0·056 *Atomic Weight*, 107·66
Tenacity in lbs., sq. in., 41,000 *Fuses at* 1023° C.

PREPARATION.—Silver ores are first combined with lead by fusion, and the alloy allowed to solidify slowly. Lead nearly free from silver crystallizes out first and is removed by ladles: the remainder is heated on a bed of bone earth in a reverberatory furnace. The lead becomes oxydized, and the fused oxide of lead is absorbed by the bone earth until, as the last trace of lead disappears, the silver suddenly brightens on the surface. This process yields what is known as fine silver, or cupel silver. It almost invariably contains both gold and palladium, the latter in sufficient quantity to totally condemn it for amalgams, in which the merest trace of palladium is a serious fault. When the ores contain sulphide or other silver salts, another and longer process of purification is necessary, which need not be referred to here.

PURIFICATION FOR AMALGAMS.—Dissolve in pure nitric acid and precipitate with common salt. The precipitated chloride of silver is thoroughly washed several times with hot water, dried, and mixed in the proportions of 3 chloride of silver to 1 of finely powdered resin. Heat slowly at first until flames cease to be given off, and then raise the heat to the melting point of silver, adding a little borax.

If the chloride is fused in the ordinary way with carbonate of soda, the loss of silver is considerable, even when the operation is performed on small quantities at once in a skittle pot, not only from the spitting, but from the absorption of the fused chloride by the crucible.

FUSED SILVER, unless covered by charcoal or a flux, absorbs oxygen, which is again given off in cooling, causing spitting and excrescences on the surface of the mass.

SILVER AND TIN.—An alloy of 5 tin, 4 silver, is still largely used for amalgams; it has less permanence in the mouth than many other alloys, notably less than silver as an amalgam, but the addition of tin reduces the discoloration of the plug.

SILVER AND MERCURY.—All alloys of silver and mercury expand more or less in hardening. When precipitated silver is used the combination takes place with such rapidity that the mass is hard in a few seconds; the evolution of heat is also considerable. The rapidity of combination is reduced by the use of a mixture of precipitated silver and filings. If the precipitate is in excess and the mass is inserted before the hardening commences, there is a risk of bursting the tooth by the gradual expansion of the mass. The expansion is readily seen by packing the amalgam in a glass tube and finishing the surface level with the glass. In a few days it will be seen to have lifted above the surface of the tube. If a great excess of mercury is used the mass only partially hardens and the results are uncertain.

Silver and Copper.—These alloy in all proportions, but the ingots are invariably irregular in composition in different parts.

Taveau's Amalgam.—This compound, which was introduced first by M. Taveau, of Paris, in 1826, consists of coin silver filings mixed with excess of mercury which was afterwards squeezed out. It has, when properly worked, a slight expansion during and after setting, and preserves the teeth well. Its intense blackness is the greatest objection to its use.

A small proportion of copper with silver in an amalgam quickens the setting, makes it cleaner to mix in the hand, but increases the discoloration.

The salts of silver are poisonous.

PLATINUM.

Specific Gravity, 21·5	*Symbol,* Pt.
Specific Heat, 0·031	*Atomic Weight,* 196·7
	Melting point, 2534° C.

The correct name for this metal is Platina (Spanish, small silver). The name has become corrupted by modern chemists, and the absurdity of a common Spanish word with a Latin termination is apparently likely to be perpetuated.

Found native, combined with palladium and other metals.

The platinum, separated from the other metals with which it is found, by dissolving in nitro-muriatic acid and precipitation, is fused in two saucer-shaped blocks of lime placed over each other, either by a large oxyhydrogen blowpipe passing through a hole in the upper block, or more recently by a blowpipe burning hydrogen gas supplied with air under very heavy pressure. It cannot be fused in an ordinary crucible, as no refractory clay known will stand the required heat without fusion, but scraps may be welded together at a bright red heat if clean.

PLATINUM AND CARBON.—These combine at temperatures over redness forming a brittle carbide of platinum.

It is therefore essential that platinum alloys shall, if required to be perfectly malleable, be melted in fireclay crucibles, which it is also advisable to line with magnesia or lime.

WORKING PLATINUM SCRAP.—Where it is necessary to work up scrap into a mass it may be fused with either arsenic or antimony. When either of these alloys is heated in the air it gives up the other metal, leaving platinum almost pure and in a fit state for working. The fusion with arsenic is a common commercial process, carried out on considerable quantities at once in the injector furnace, the alloy being cast and afterwards heated to expel the arsenic. As the vapours are excessively poisonous, great care and perfect ventilation are absolutely necessary for safety.

PLATINUM AND CADMIUM, made by fusing excess of cadmium with platinum and driving off the excess of cadmium by heat, contains 46·02 platinum (1 equiv.) and 59·98 cadmium (2 equiv.). White, fine grained, and very infusible—no commercial use at present.

PLATINUM AND TIN.—3 platinum, 16 tin, make a brittle alloy which crystallizes and remains unchanged in moist air. 12 tin, 1 platinum, slightly malleable.

PLATINUM AND STEEL.—A small proportion of platinum improves the qualities of steel in all points except liability to rust, which is increased.

Palatinum and Nickel.—Equal parts make a fine malleable alloy of a pale yellow colour melting at a bright red. Not yet sufficiently examined.

Platinum and Copper.—The soft platinum used for chemical purposes is frequently alloyed with a small quantity of copper to give it hardness for dental purposes. This alloy, commonly used in England by dentists, is neither used nor saleable at the dental depôts in America, where the purer soft platinum alone is used. The peculiar harshness and rigidity of the copper alloy is objectionable, as the malleability of the platinum is greatly injured, although the rigidity enables the plates to be made much thinner for the same stiffness.

Platinum, Copper, and Zinc.—7 platinum, 16 copper, fused together under borax and then 1 part zinc added, is stated by Gmelin to yield a gold-coloured highly extensible alloy which does not oxydate by roasting, and is not attacked by boiling sulphuric acid.

Platinum and Mercury.—Spongy platinum combines with mercury when worked together in a warm mortar. This amalgam has not yet been sufficiently examined for dental purposes. It may be made as a paste and used for covering silver, &c., with platinum by driving off the mercury by heat and hammering the porous surface of platinum left.

PLATINUM AND SILVER.—This alloy, known as dental alloy, is exceedingly difficult to make uniform. A layer richer in platinum collects at the bottom of the crucible and becomes mixed in streaks in the ingot when poured. These streaks can always be seen when the alloy is blackened by immersion in hydrochloric acid.

The best way to make this alloy is to melt with excess of platinum in a fireclay crucible in the injector furnace at a heat just below the softening point of the crucible; stir repeatedly with a claypipe steam, and pour quickly into an oiled ingot mould. If streaky it should be remelted, placing the button left in the crucible on the top of the metal which has been previously poured.

Hot sulphuric acid will remove the silver from the surface of the alloy, leaving a nearly pure face of platinum.

PLATINUM AND GOLD.—Platinum is frequently added to gold for dental purposes to produce a hard alloy. The hardness and elasticity of the alloy known as lemel, produced by melting dentists' waste, is principally caused by the platinum present. The use of platinum in gold for plates, so frequently recommended in America, is a mistake. It has not the permanence and resistance to acids shown by the ordinary alloy commonly used in England.

PLATINUM GIVES TO AMALGAMS the property of rapid hardening. The value of this property, discovered by myself some years ago, has been recognized by almost every maker of amalgams in the world. It communicates to an amalgam also the power of retaining its form after hardening, provided it is in sufficient quantity; but in this case it also causes a dirtiness in mixing in the hand which can only be remedied by adding a large proportion of fine gold. It is now a common custom of some makers to replace platinum by copper, copper having the same power to cause quick setting without, however, being able to prevent the objectionable change in form after hardening. The difference between the two can be usually recognized with ease by packing the amalgam in a glass cup of about $\frac{3}{8}$ in. diameter and covering it with a coloured fluid and sealing over with wax. The changes in form will be readily seen from day to day—often lasting for months. For comparative testing the packing of these plugs must be done with great care, and the mercury must be in so small a quantity as not to work up to the surface, or the amalgam becomes irregular in composition in different parts and of no value as a test.

The peculiar dirtiness and adhesiveness in the hand caused by alloys containing platinum is simply the result of the perfect fit produced by the amalgam.

To fill the general requirements of dentists at present this dirtiness, really a valuable quality, is not admissible, and it must be corrected by the addition of other metals.

Of the modern alloys for amalgams, all which I have examined, without exception, contain either platinum or copper, sometimes both. Those quick-setting alloys which are acknowledged not to contain platinum contain copper in its place, which, as before stated, does not communicate the permanence of form only to be obtained, so far as is known at present, by platinum.

PLATINUM AND IRIDIUM.—A small percentage iridium greatly increases the hardness of platinum and improves its qualities for all purposes except where softness is necessary.

PLATINUM FOIL coated with cohesive gold has been and is used for filling. The peculiar harshness of the metal renders it difficult to insert a plug, except in the simplest cavities, so as to be water-tight. When this can be done it makes exceedingly good work without the objectionable colour of gold, the plugs being almost white when finished.

PALLADIUM.

Atomic Weight, 106·2 *Symbol*, Pd.
Specific Gravity, 11·4 *Melting Point*, about 1600°C.
Specific Heat, about 0·059

Found native in a pure state, and also reduced from ores containing it by processes too complicated and troublesome to be of interest to dentists. By igniting the cyanide or the ammonio-protochloride the metal is obtained as a light spongy mass, too dense, however, to use with mercury as an amalgam.

PRECIPITATED PALLADIUM may be prepared from a solution of any of its salts, or the metal may be dissolved in nitro-muriatic acid, the excess of acid being driven off by evaporating nearly to dryness and the resulting salt dissolved in water. From this solution the metal may be precipitated in a form suitable for dentists' use by metallic iron or zinc, the precipitate washed with weak nitric acid and dried.

It may be prepared to combine with mercury so as to set quickly or slowly by varying the strength of the solution, but it must be borne in mind that unless precipitated palladium sets very rapidly when mixed with mercury, it is totally useless for dental purposes: the plugs fail, unless fully hard, in so short a time that the amalgam is difficult to insert whilst it remains plastic. Plugs of palladium amalgam generally contain about 70 to 80 per cent. of mercury.

Palladium combines with antimony, bismuth, zinc, tin, iron and lead, forming very brittle alloys.

PALLADIUM AND NICKEL.—Malleable alloys taking a brilliant polish. Not sufficiently examined.

PALLADIUM AND SILVER.—An alloy very poor in palladium has been recently introduced under the name of "Palladium." This alloy is practically worthless, a large percentage of palladium is necessary to protect silver from the action of sulphuretted hydrogen, and the present excessive cost practically prohibits its use for this purpose. Pure palladium, if obtainable at a reasonable price, is the best metal known for plates for artificial teeth, owing to its high specific heat, its extreme lightness and hardness, requiring no alloy, and also to its absolute freedom from tarnish.

As an alloy, the presence of palladium in small quantities is frequently objectionable. It is, so far as is known at present, almost inadmissible, even in so small proportion as 1 in 2000 in silver for making amalgams. It is almost invariably present in every sample of silver, and may be separated by dissolving in nitric acid and precipitating the silver as chloride, the palladium and gold present in the silver being left in solution.

TIN.

Atomic Weight, 117·8	*Symbol*, Sn.
Melting point, 228°C.	*Specific Gravity*, 7·3
Specific Heat, 0·051	*Crystalline.*
	Malleable.

Resistance to crushing in lbs., sq. in., 15,000
Tenacity ,, ,, 5,000

PREPARATION.—The ore is roasted, to drive off sulphur and arsenic and convert the other metals into light oxides readily separated from the heavier tin stone by washing, and is then fused in contact with charcoal.

The purest tin in commerce is grain tin, easily recognized by its form, which is a mass of imperfectly formed crystals.

It almost invariably contains arsenic, and also frequently copper ; for amalgams and special purposes it must be purified by oxydizing finely divided tin with excess of nitric acid, washing the resulting binoxide with hydrochloric acid and water, and reducing with charcoal in a crucible at a bright yellow heat approaching white.

ALLOYS OF TIN.

Tin 12, antimony 1, is the alloy called pewter. The addition of bismuth to tin lowers its fusing point considerably.

Tin 12 copper 2, antimony 3, forms a good alloy for casting dies, superior to zinc.

Tin 5, silver 4, Townshend's amalgam, is the common alloy in general use. This amalgam does not retain its shape after hardening: the plugs almost invariably lift at the edges after being in the mouth some time.

Tin 10, silver 8, gold 1, is an alloy also generally sold for amalgams. It is rather pleasanter to use than the preceding, but is not to be depended on for good work. Different makers vary the proportions slightly, but practically all are alike.

Tin 10, silver 8, gold 1, copper 1, has been largely used for some years both as the so-called gold amalgams and also the platinum amalgams. Copper in small quantity, from 5 to 7 per cent., has to a certain extent the property of replacing platinum in an amalgam, giving the alloy the peculiar quick setting caused by platinum. and also preventing the dirtiness in the hand which is caused by platinum, and which with the latter metal requires to be corrected by the addition of gold in larger proportion.

Copper can only be considered an inferior substitute for platinum, as it imparts only to a very slight extent the permanence of form given by platinum. In the absence of platinum a very small proportion of copper distinctly improves any amalgam without affecting its colour to any appreciable extent.

ALLOYS CONTAINING TIN AND SILVER are always exceedingly difficult to make uniform, more especially if, as is almost invariably the case, the silver contains a trace of palladium, and they are never reliable for dental purposes without thorough and systematic testing for all required properties. The absence of palladium simplifies the matter to a great extent, but does not do away entirely with the difficulty.

FUSIBLE PLUGS.

Tin 5,	lead 3,	bismuth, 7,	mercury 3,	fuses at	50° C.
,, 5	,, 3	,, 3	202 F	,, ,,	94° C.
,, 1	,, 2	,, 4		,, ,,	95° C.
,, 4	,, 4	,, 1		fuses at 320° F.	160° C.
,, 6	,, 1			,, 383° F.	190° C.
,, 5	,, 3	,, 8. (Melotte's Metal)			

MODELLING TRAYS.—When these are required of special shapes and the metal cannot be bought in the sheet, they may be made of tin cast and rolled to the right thickness; common tinman's solder, or an alloy of tin 2, and lead 1, can be used for soldering

,, 3 ,, 5 ,, 8. Newton's Metal. 202 F.

,, 3 5 ,, 10½ Dalton's Metal. 197 F.

the joints. Trays made of pure tin do not discolour, and are far preferable to the ordinary pewter or Britannia metal trays.

Britannia Metal.—Tin 42, antimony 3, copper 1, brass 1.

Salts of tin, as a rule, are poisonous if soluble.

IRON.

Specific Gravity,	7·84	*Melting point* (pure)	1600°C.
Specific Heat,	0·011	*Atomic Weight,*	56·0
		Malleable.	

Resistance to crushing in lbs., sq. in., 38,000
Tenacity „ „ 60,000

Not prepared on a laboratory scale.

Pure bar iron becomes soft at a red heat, and may be welded at a white heat.

If it contains sulphur it is brittle when hot: if phosphorous it is brittle when cold.

The successive shades of yellow, red, blue, and grey with which iron or steel becomes covered, are caused by very thin films of Ferrosoferric oxide—($Fe\ O\ FeO^3$)—which transmit light more or less, producing the tints of Newton's coloured rings.

A COHERENT COVERING of the magnetic oxide, which preserves iron or steel from rust under ordinary conditions, may be formed by exposing the iron at a high temperature in closed chambers to the action of steam (Barff's process). Iron or steel may also be protected from rust by complete immersion in a weak solution of soda or any alkali.

PURE IRON.—Malleable or wrought iron.—This is largely used for workshop purposes, and its good qualities increase in proportion to its freedom from carbon, sulphur, and phosphorus, which are, however, almost always present in varying proportions.

STEEL.—Thin bars of pure iron are enclosed in pots filled with charcoal powder, and kept at a red heat for 5 to 8 days. The carbon gradually penetrates the iron, forming steel. If the process is continued too long an excess of carbon is taken up, and the bars fuse together, forming cast iron.

INDIAN STEEL OR WOOTZ contains a very small proportion of aluminium, and may be imitated by fusing steel with aluminium. It is distinguished by its extraordinary hardness.

Steel fuses at about 2530°C. At 215°C. it turns straw yellow, at 282°C. it becomes purple. By repeated exposure to a red heat in contact with air steel is converted into iron, the carbon being burnt away: it is, therefore, advisable in making fine steel tools to heat them to the lowest temperature at which they can be worked, and to do this as seldom as possible. Steel may be readily melted in small quantities in the injector furnace, but it is difficult to make sound castings; they are almost invariably porous and full of bubbles; steel is usually cast under a very heavy head of metal, or under hydraulic pressure.

BERLIN IRON CASTINGS.

Cast Iron contains more carbon than steel. It is more fusible than steel, and is extremely easy to melt in the injector furnace. The production of fine castings in iron is a very simple matter, and many of the castings now made in zinc would be better made in iron. The impressions which can be reproduced in cast iron are wonderfully delicate, and markings of almost microscopic fineness are reproduced with ease. There have been occasionally some very delicate castings exhibited as curiosities, and which are made in Berlin. These are produced by grinding and sifting, or levigating fine casting sand until an impalpable powder is obtained, which is mixed with paraffin oil or water, and painted on the pattern. This is then backed up with common casting sand, which absorbs the excess of moisture and adheres firmly to the fine coating, thus producing an exceedingly fine surface to the mould. By this means castings of intricate patterns, weighing only a few grains, are produced. I have had many castings of iron produced in this manner weighing from 2 to 5 grains, the surfaces of which were covered with delicate tracery. Ordinary cast iron when so thin as this is very liable to fracture, and is converted by the following process into malleable iron.

Malleable Iron.—The carbon may be removed from cast iron, making it identical with wrought iron in chemical and mechanical properties, by enclosing the castings in close vessels, the space between the castings and the vessel being filled with chalk, ashes, or oxide of iron, so as to exclude air as much as possible; and heating to redness for several days, the time required depending on the thickness of the casting from which the carbon has to be removed.

Sulphide of Iron (Spence's metal).—See Antimony.

ALLOYS.

Iron and Zinc form a brittle alloy. It is this alloy which causes the so-called galvanized iron to be brittle and worthless when the zinc bath in which the iron is immersed is at too high a temperature.

IRON AND TIN form a slightly malleable alloy which does not cause the same deterioration of the iron when tinned as when coated with zinc.

Cast iron 79, tin 19·5, lead 1·5, a good casting metal, giving sharp impressions.

TEMPERING STEEL.

	FAHRENHEIT.	CENTIGRADE.
Light straw colour	430°	221°
Dark straw	470°	243°

The above for wood, ivory, and vulcanite tools.

Brown yellow	500°	260°

For gravers and tools for metal cutting.

Bright blue	550°	288°

For springs and saws.

FORGING FINE STEEL INSTRUMENTS.—These must never be heated in an ordinary blowpipe flame, as it ruins the quality of the steel. Direct the jet downwards on a block of charcoal and heat the steel with the rebound of the flame from the charcoal, which gives a saturated bath of carbonic acid. In the absence of charcoal heat in the white part of the flame of a common lighting burner—do not heat too quickly, and work at the lowest temperature possible, hammering until nearly cold. Harden by sticking the point into a tallow candle.

A thin coating of soap prevents scaling in hardening to a great extent, but not entirely. Polished instruments may be hardened and tempered without losing their polish by wrapping tightly with thin soft platinum foil. Chronometer springs are coiled on an iron or steel mandril, covered with platinum foil and hardened in the same manner without losing their polish.

NICKEL.

Atomic Weight, 58·8 *Symbol*, Ni.
Specific Heat, 0·103 *Specific Gravity*, 8·8
Melts at a blinding white heat, 1600° C.

PREPARATION.—Nickel oxide is mixed with about 5 per cent. of finely divided carbon, and exposed to a clear white heat in perfectly close vessels. It may be reduced in the injector furnace in a covered crucible in about 25 minutes, the heat required being just below the softening point of the most refractory clay crucibles. If the nickel oxide is pure and in excess, the nickel obtained is malleable. If the carbon is in excess, the nickel is hard and brittle, the two forms corresponding to wrought or malleable and cast iron. If nickel is fused with a small quantity of either manganese or aluminium it becomes very malleable and ductile, working with ease like soft wrought iron. In this form it might, and probably will, eventually, supersede wrought iron for all instruments where freedom from liability to rust is of importance. The cost has recently been greatly reduced, and is not now an insuperable objection to its free use.

Nickel is frequently reduced from its ores in combination with copper, forming an alloy which is used for making an alloy called Nickel silver, Spanish silver, German silver, and other ridiculous names, but which is in reality a nickel brass, *i.e.*, brass rendered white by the addition of a small proportion of nickel.

Nickel is largely used for electro-plating, and its valuable properties for this purpose are well known. Nickel plating cannot be economically done on a small scale, and it is now so cheaply done, depositing by dynamo-electric machines from the double chloride of nickel and ammonia, using a dissolving plate of cast or rolled nickel, that the process needs no further description. It has been proved that nickel plating does not entirely prevent the rusting of iron and steel. Where the total prevention of rust is necessary it is now usual to cover the steel or iron first with a deposit of bronze, and then covering this with nickel. The protection by this method is perfect.

The salts of nickel are poisonous and generally of very intense colour, so that its use as an alloy for fillings, although otherwise favourable, is out of the question.

ALLOYS.

NICKEL AND IRON unite in all proportions, forming an alloy similar in properties to iron, and less liable to rust in proportion to the quantity of nickel contained in the alloy. The carbide, *i.e.*, nickel and steel, is, on the contrary, more liable to rust than steel alone.

GERMAN SILVER, or Nickel Silver, is an alloy of nickel, copper, and zinc, the best alloy in use being about 6 nickel, 20 copper, 8 zinc.

MAGNESIUM.

This is at present used only by dentists in the form of ribbon or wire to burn for the production of a white light of great power for matching artificial teeth and operations in the mouth in the absence of daylight.

The salts of magnesium are not poisonous.

MERCURY.

Atomic Weight,	199·8	*Symbol*,	Hg.
Specific Heat,	0·032	*Specific Gravity*,	13·59
		Boils at 357·25 *Regnault*	

PREPARATION.—By distilling mercurial ores in contact with lime or oxide of iron to remove the sulphur.

PREPARATION IN PURE STATE. — 1. By distilling corrosive sublimate mixed with iron filings. 2. By distilling red oxide of mercury and afterwards agitating with dilute nitric acid. 3. By boiling a solution of corrosive sublimate in a clean iron vessel. 4. By covering mercury with very weak nitric acid and heating for three or four hours; the latter process fills every requirement for dental purposes.

ALLOYS.

MERCURY AND SODIUM.—These combine in all proportions, forming a pasty or fluid alloy, which has the property of amalgamating many metals which do not readily combine with mercury alone; for instance, cast iron, if rubbed with this alloy, is perfectly amalgamated, and admits of being soft soldered with a blowpipe or copper bit, making a firm joint which cannot be obtained by any other process of soldering.

To make this amalgam, place in a dry test tube a globule of mercury about twice the size of a pea, cut off a piece of sodium about half the size, carefully free it from naphtha with blotting paper, then cut it into a number of very small bits, and having heated the mercury slightly, add the bits of sodium one by one, The metals will combine with a slight explosion, forming a pasty amalgam, which must be kept in a closely stoppered bottle.

MERCURY AND POTASSIUM.—Similar to the above.

MERCURY AND BISMUTH.—Similar in many properties to the amalgam of copper and mercury known as Sullivan's amalgam (see Copper), but not practically applied for fillings at present.

MERCURY AND ZINC.—Similar to above, but brittle.

AMALGAMS FOR FILLING TEETH.—See Copper, Tin, Silver, Palladium, and Platinum.

MERCURY AND NICKEL.—Not permanent; the nickel oxydizes out on exposure to air, leaving fluid mercury.

MERCURY IN ALLOYS AND AMALGAMS.—It is the common custom for alloys, made with the greatest precision and care, to be mixed with varying proportions of mercury according to the ideas of the user. It is well known, and also appreciable to all who give the matter a thought, that a variation in one constituent of an alloy alters the whole character of the compound, that a variation in mercury is no more to be permitted than a variation in any other metal where uniform results are expected. It is therefore an absolute necessity that the proportions of alloy and mercury shall be weighed. Until this is done uniform results are not to be expected.

The salts of mercury are poisonous.

ALUMINIUM.

Atomic Weight, 27·3 *Symbol*, Al.
Fusing Point, 700° C. *Specific Gravity*, 2·6

Prepared by reducing the oxide (alumina) by potassium or sodium with the assistance of heat.

Alloys with iron, but the alloy is little known. Fused with copper, it forms what is known as aluminium bronze, or aluminium gold.

Aluminium at one time was expected to prove a valuable material for artificial dentures. Why a metal so readily soluble in alkalis and in hydrochloric acid should ever have been used in the mouth with any hope of permanence it is difficult to understand; the slightest chemical knowledge would have prevented a blunder which could hardly be anything but an expense to the dentist and an annoyance to the wearer.

The salts of aluminium are not poisonous.

ANTIMONY.

Atomic Weight, 122 *Symbol*, Sb.
Specific Gravity, 6·8 *Melting point*, 512° C.
Tenacity in lbs., sq.in., 1066 *Specific Heat*, 0·050

Stated by Holtzapffel to expand in cooling.

PREPARATION.—Heat 8 parts by weight of sulphide of antimony—mixed with 6 parts of cream of tartar, in a crucible to near redness, and add sufficient nitrate of potash (2 to 3 parts) until the mass is perfectly fused: Or, a mixture of 177 parts of sulphide of antimony with 82 parts iron filings heated to bright redness in a closely covered crucible and allowed to cool without disturbance.

The iron takes up the whole of the sulphur at a low red heat, but the mixture requires a bright heat to fuse the sulphide of iron and metallic antimony to enable them to separate into layers in the crucible.

Pure antimony fuses before the blowpipe on charcoal, forming a shining bead which burns completely away with evolution of inodorous vapours, and becomes covered, on cooling, with white needles of antimonic oxide. Impure antimony exhales a garlic odour when fused, becomes covered with slag, has a dull surface, and ceases to burn when the blowpipe flame is withdrawn; the oxide given off is also yellow.

SPENCE'S METAL

FOR MAKING DIES FOR METAL DENTURES, FOR MAKING DIES FOR METAL CROWNS, AND FOR MAKING MOULDS FOR PORCELAIN INLAYS.

With **Spence's Metal** the finest markings on an impression can be more sharply reproduced than with any other metal.

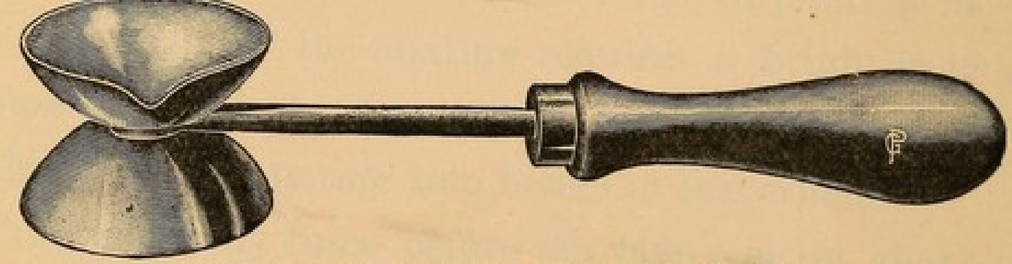
For swaging purposes no other metal can be compared with it, for, although brittle under the hammer, it is extremely hard and does not spread under swaging pressure.

It is particularly suitable for making the mould in which the foil matrix is swaged for a porcelain inlay, as its expansion and contraction are practically nil.

DIRECTIONS FOR USE.

Owing to the peculiar behaviour of **Spence's Metal,** it is absolutely necessary to be careful in melting it.

To prevent burning the metal and to obtain uniformly good results, the ladle containing it must be held some little distance above the flame until the metal melts. *(The ladle here illustrated is specially adapted for use in melting Spence's Metal. It is made in two sizes—large for general use and small for Crown and Inlay Work.)*



Christensen's Ladle for melting Spence's Metal.

When melted it has the appearance of a spongy mass, and must not be poured while in this condition, but placed on the bench and stirred with a stick until it settles down, becomes clear and free from bubbles.

During the settling down process it seems to stiffen before it finally liquefies. This liquid condition must be looked for and when it appears the metal must be quickly poured.

With ordinary care no trouble will arise, but if the ladle is held so near to the flame that the metal burns, sulphurous fumes are given off which are objectionable.

CLAUDIUS ASH & SONS, Ltd.,

5, 6, 7, 8 & 9, Broad Street, Golden Square,

LONDON, W.

A solution of antimony in nitro-muriatic acid gives a yellowish red precipitate with hydrosulphate of ammonia: the precipitate is perfectly soluble in excess of the precipitant. A black precipitate denotes the presence of impurities—probably lead, iron, or copper.

SPENCE'S METAL.

ANTIMONY SULPHIDE.—This, like most of the metallic sulphides, may be dissolved with the aid of heat in excess of sulphur, forming a compound known as Spence's metal, which can be used for casting purposes. These compounds are, however, too brittle for the usual requirements of dentists, although they possibly might be useful for forming dies in some cases where plaster of Paris is too soft.

ALLOYS OF ANTIMONY, with Bismuth, Zinc, Tin, Lead, Copper, Nickel, Silver, Mercury, Gold, Platinum and Palladium, are all white and brittle when the antimony is in excess.

Antimony 4, tin 5, and silver 4, has been used as an alloy for amalgams; but it has no properties essentially different from other common amalgams in which antimony is absent.

(Babbit's metal) 1. 2. 8.

CASTING METAL FOR DIES.—Copper 2, antimony 3, tin 12: the antimony must be added after the other metals are perfectly fused and mixed. This makes a much harder die than zinc, and is in many respects superior.

The salts of antimony are poisonous.

COPPER.

Atomic Weight, 63·1 *Specific Gravity*, 8·95
Specific Heat, 0·095 *Melts at* 1173° C.
Symbol, Cu.

Found native or reduced from the oxide by fusion with charcoal.

Welds at a red heat.

If exposed to air during fusion it absorbs oxygen, whicn is given off in cooling, causing the mass to be porous. If melted under charcoal or common salt this does not take place, and a solid casting may be obtained.

Copper Sulphide.—See Antimony.

ALLOYS.

Sullivan's Amalgam.—Precipitate from a weak solution of sulphate of copper by rods of pure zinc. Wash the precipitated copper with strong sulphuric acid (the addition of a small quantity of nitrate of mercury assists greatly), and add mercury in the proportion of 3 copper to 6 or 7 mercury. This alloy has the property of softening with heat and again hardening after a few hours. It is an absolutely permanent filling, as the copper salts penetrate and perfectly preserve the tooth. If after a time the filling is removed the decay is still permanently arrested, owing to the protecting action of the copper salts absorbed. The intense blue black colour of the teeth in which this alloy is used is the only objection to its use, as the loss in weight by solution in the mouth is so small as not to be injurious, although the alloy is intensely poisonous if dissolved.

1	copper,	2	bismuth,	expands strongly on cooling.
7	,,	3	zinc,	Ordinary brass.
26	,,	34	,,	Hardest alloy.
91	,,	9	,,	Most malleable alloy.
33	,,	67	,,	Most tenacious alloy.
31½	,,	68½	,,	A white alloy.

6 brass, 5 silver, 2 zinc, common silver solder ; 13 copper, 12 pure silver, fine silver solder.

19	copper,	1 tin,	malleable bronze, fuses	1300° C.
9	,,	1 ,,	gun metal, fuses	1160° C.
4	,,	1 ,,	bell metal ,,	1050° C.
2	,,	1 ,,	1-10 arsenic, speculum metal.	
10	,,	4 nickel,	white as silver.	
2	,,	1 zinc,	nickel silver (so called).	

Copper 10, arsenic 1, is so similar in appearance to silver as to have been substituted for it.

Copper 3, lead 1 to $1\frac{1}{2}$, pot or cock metal, used for very common brasswork.

Copper 6, zinc 4, Muntz metal, will roll and work at a red heat.

Copper 1, zinc 1, spelter solder for brazing.

Ordinary brass is sensibly hardened by a very slight addition of tin.

The salts of copper are poisonous.

LEAD.

Specific Gravity, 11·45	*Symbol*, Pb.
Melting point, 334° C.	*Atomic Weight*, 206·4
Specific Heat, 0·030	*Boils at* 1040° C.

Resistance to crushing in lbs., sq. in., 7000
Tenacity ,, ,, 1824

PREPARATION.—Native Carbonate, or Litharge, is fused in contact with charcoal. If the ore contains sulphur it requires to be roasted previous to its fusion.

Native lead almost always contains gold and silver, and a large portion of the silver of commerce is obtained from this source.

LEAD SULPHIDE (Spence's metal).—See Antimony.

ALLOYS.

LEAD TIN.—Unite in all proportions, forming soft solder. The alloy is harder, more tenacious, and more fusible than either tin or lead alone.

5 lead, 8 bismuth, 3 tin, form an alloy which fuses below the boiling point of water.

The salts of lead are poisonous.

Metallic lead in sheet has frequently been used for fillings; in fact, the French word for filling, *plombage*, which means leading, comes from the general use of lead for this purpose. I have seen plugs of lead foil which have remained perfect in the mouth for a great number of years.

BISMUTH.

Atomic Weight, 210	*Specific Gravity*, 9·823
Specific Heat, 0·029	*Melting point*, 270° C.
Symbol, Bi.	*Crystalline.*
	Not malleable.

PREPARATION.—Found native, requires a gentle heat to fuse it from the matrix.

PURIFICATION.—Dissolve in nitric acid, pour the clear solution off, and precipitate by the addition of water. The pure mono-nitrate of bismuth which is precipitated is mixed with charcoal and fused in a crucible to reduce it to the metallic form. The mass when cold and broken is composed of brilliant reddish white crystals, which show little or no tendency to tarnish when exposed to air for a long period.

Bismuth when fused expands in solidifying, and communicates this property to alloys containing it. It also considerably lowers the fusing point of any metal or alloy.

ALLOYS.—The addition of bismuth to amalgams makes them excessively sticky and adhesive, necesitating, at the same time, an increase in the proportion of mercury required.

Amalgams containing a trace of bismuth will build and adhere to a flat dry surface, and may be used as a metallic cement for joints in apparatus which require to be perfectly air tight and to stand heavy pressures. A good alloy for this purpose is 1 bismuth, 15 tin, 15 silver, fused and filed up, and then mixed in the proportion of 1 alloy to 4 of mercury. This alloy is so excessively sticky as to be useless for fillings.

An alloy of 3 parts each bismuth, fine gold, and platinum with 15 of fine silver, and 10 of tin, is very similar to precipitated palladium, and has been used as a substitute for this costly metal. One curious point about this alloy is that if it contains the merest trace of palladium it is almost worthless; and, as ordinary fine silver is rarely if ever free from palladium, this alloy can only be made from silver reduced direct from the chloride. 8 bismuth, 5 lead, 4 tin, type metal, forms the fusible alloy used on the Continent for producing the beautiful casts of the French medals by the clichée process.

1 bismuth 2 tin; the best alloy for turning in the lathe. Used for producing patterns of rose engine and geometric turning for printing from.

The salts of bismuth are not poisonous.

ZINC.

Atomic Weight, 64·9	*Specific Gravity, cast* 6·9, *rolled* 7·2
Specific Heat, 0·092	
Melting point, 411°C.	*Malleable and ductile, more especially when warm.*
Symbol, Zn.	*Boils at* 1040°C.
Tenacity in lbs., sq. in., 8000	

PREPARATION.—Zinc oxide, or the roasted native carbonate or silicate, is mixed with one-eighth its weight of charcoal powder, and heated to whiteness in retorts of earthenware or iron. The zinc is reduced and volatilized, and condenses in the colder parts of the apparatus.

PURIFICATION.—After repeated use as dies, zinc becomes thick and useless. It can be perfectly purified for use by the following processes. The first is recommended as the best and simplest.

1.—Heat the zinc to dull redness in a ladle and pour on it a small quantity of strong hydrochloric acid, stirring sharply with a stick; the evolved gases ignite on the surface, and a thick dross separates and floats on the metal. About one tablespoonful at once, repeated two or three times at intervals of a few seconds, will perfectly clear 10 or 12 lbs. of zinc. This process does not remove iron.

2.—Sulphur, mixed with grease, is sharply stirred about at the bottom of melted zinc in order to convert the foreign metals into sulphides.

Neither of the above processes will remove lead, which can be got rid of by allowing it to settle and cutting it out. The lead can readily be formed by a chisel owing to its softness.

Sulphide of Zinc.—See Antimony.

Oxide of Zinc.—This is largely used in filling materials. The oxide for this purpose is prepared in several different ways.

1.—The heavier part of the sublimed oxide formed by the combustion of metallic zinc is collected from the flues and separated by passing through a winnowing apparatus or other means.

2.—Pure zinc oxide is compressed into porcelain crucibles and heated to intense whiteness for a time depending on the size of the crucible. The semi-vitreous mass obtained is broken up by stamps and separated by sifting through silk sieves.

3.—The oxide is rammed into strong steel chambers and exposed to a hydraulic pressure of not less than 90 to 100 tons on the square inch. The hard, marble-like block obtained is cut out with chisels, broken up by stamps, and sifted as before described.

4.—Pure metallic zinc is dissolved in pure nitric acid, the solution evaporated in porcelain vessels until it solidifies in cooling, and then is heated to redness in porcelain crucibles. If the heat is gradually applied the oxide may be produced by this process in fairly large crystals which are almost as hard as corundum.

The oxide prepared by 1 and 4 is sufficiently hard to cut glass, and the difference between the oxides prepared by the above processes can be readily distinguished by the microscope.

Zinc oxide in an extremely dense form is also produced by the reduction of heavy zinc compounds, such as the silicate, or zinc spar (carbonate) with or without the assistance of other substances, and with the assistance of heat. It is probable, however, that these processes are superseded for the simple and more satisfactory ones given previously. Although not a zinc compound, it may be as well to mention here that a mixture of sulphate of lime and oxide of iron, corresponding to what is now known as Roman Cement, has been used for fillings, but the colour is objectionable, and the reports as to its permanence are not satisfactory.

ALLOYS.

ZINC ANTIMONY.—Hard brittle steel coloured alloy. Properties little known.

ZINC BISMUTH.—Do not combine readily, and separate on fusion.

ZINC LEAD.—Same as zinc bismuth. A mixture of these metals, which can hardly be considered a true alloy, is used for composition gas piping.

ZINC TIN.—This alloy in almost any proportion is superior to zinc alone for dies. The impression from the sand is much finer, the shrinkage in cooling is greatly reduced and is more equal. 2 zinc, 1 tin, will probably be found the best proportion.

Owing to the low temperature at which this alloy melts care must be taken to have the dies perfectly cold before pouring on the lead for the counter die, and the lead must be barely hot enough to pour and not sufficiently hot to char a slip of paper.

CADMIUM.

Atomic Weight, 112·3	*Symbol*, Cd.
Melting point, 320°C.	*Specific Gravity*, 8·7
Specific Heat, 0·038	*Crystalline.*
	Malleable.

PREPARED from the sulphide by dissolving in strong hydrochloric acid and the excess of acid expelled by evaporation. The cadium is then precipitated by carbonate of ammonia added in slight excess, to re-dissolve any copper or zinc which may be present. The precipitate is washed, heated to redness, mixed with thoroughly ignited lampblack and heated to redness in glass or earthen retorts: the metal then distils over. In colour and lustre it has a strong resemblance to tin, but is harder and more tenacious. It is very ductile, malleable, and nearly as volatile as mercury, condensing like it into globules which have a metallic lustre; its vapour has no smell. When heated in the open air it becomes slowly converted into oxide. The sulphide of cadium, which frequently forms on plugs containing this metal, is yellowish orange in colour and is insoluble in alkalis.

THE USE OF CADMIUM has been so repeatedly condemned for all dental purposes that a notice here would be unnecessary but for the fact that it has again been recently introduced in amalgams, to which it imparts the property of malleability.

MALLEABLE AMALGAMS, which owe their peculiar properties to the presence of cadmium only, cannot be too strongly condemned, and those who make and offer them for sale damage the reputation of the unfortunate dentists who are persuaded by their plausible statements to use compounds which, if the makers know anything, they must know are utterly worthless.

Cadmium may be detected in an alloy by its forming brownish yellow or red film on charcoal if heated by the blowpipe.

THE ALLOYS have no practical value to dentists. Cadmium was first introduced as a filling material by Dr. Evans, of Paris, in 1848, the alloy he used being tin, with a small proportion of cadmium.

TUNGSTEN.

This metal, which bears some resemblance to steel, is of no importance to the dentist. The tungstates, more especially the tungstate of soda, have an exceedingly powerful tanning and hardening action on animal tissues, and may probably become valuable to the operator for nerve treatment. Leather, when treated with tungstate of soda, and more especially before it has been tanned by the ordinary process, becomes as hard as wood.

ADDENDA.

[*Reprinted from* Design and Work, *March*, 1881.]

THE USE OF THE BLOWPIPE.

By THOMAS FLETCHER, F.C.S., WARRINGTON.

In this series of papers it is intended to treat only the use of the blowpipe for workshop purposes. As an instrument for chemical analysis the matter has already been exhaustively treated in several works.

All blowpipes may be considered as a means of introducing air, under pressure, to the internal part of an ordinary flame, in such a manner as to supply rapidly the amount of oxygen necessary for perfect combustion. The quicker this oxygen can be mixed with the flame the higher the temperature obtained and the smaller the flame—in fact, given a certain definite amount of combustible matter consumed in a certain time, the smaller the flame obtained, the higher its temperature.

For example, given two gas flames consuming each five cubic feet per hour, the flames being of different sizes, the smallest flame has the highest temperature, and is the most efficient for heating purposes. It will be seen that when a blast of air is directed into the middle of a flame, the size of the flame is instantly reduced, and, provided the air supply is not in excess, the temperature of the flame is increased in exact proportion to the reduction in its size. The simplest and most generally used form of blowpipe is the common plumbers' or jewellers' pattern, and it is astonishing what wonders can be done by this simple instrument with a little practice.

With the mouth blowpipe the first thing to be learnt is the art of blowing in a continuous stream, without stopping to breathe—in fact, to render the blowing perfectly independent of the breathing. How to do this is most difficult to describe. It comes as an instinct to most users of the blowpipe, but many fail totally to produce a continuous blast, notwithstanding the practical and theoretical instructions which have so repeatedly been given.

It would appear, as nearly as the process can be described, that the cheeks are filled with air, and that whilst the breath is inhaled through the nose, the mouth is closed at the back by lifting the back part of the tongue (not the tip) against the roof of the mouth, the air being taken into the mouth by "gulps" and the cheeks acting as an elastic reservoir. This becomes so easy to many constant users of the blowpipe that it is common to find workmen who can keep up a steady and heavy blast for 15 or 20 minutes without the slightest break or irregularity, the breathing going on steadily and without effort all the time.

Plumbers and gasfitters frequently hold the blowpipe between the teeth, without any support for the tip, but very few can hold it steadily so as to get the best work out of it, as the jet of air must be directed into one exact point of the flame to get the best results. The difficulty of holding the blowpipe steadily is greatly reduced by soldering on to the stem, about one inch from the opening, a curved plate of tin or Britannia metal, as shown in Fig. 1.

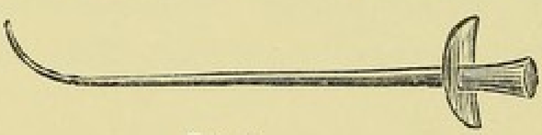


FIG. 1.

With this addition, the blowpipe is not only held in the teeth, but the plate, being curved to the shape of the mouth, forms a support to the lips, and increases the power of blowing with heavy pressure. The plate is sometimes made small enough to go inside the lips, and is preferred by many when used in this manner. Whether used inside the lips or outside, it is a great advantage, steadying the blowpipe, and reducing the labour of blowing very considerably.

It may be taken as a rule that the mouth blowpipe cannot be used with a jet over one-sixteenth inch in diameter. Few can use one with a jet even this size, and the work which can be done by the mouth is therefore limited in dimensions. It is considered a maximum feat for an average workman to melt an old copper half-penny on a block of pumice-stone, and anyone who can do this may consider himself as good as the crowd, and better than a good many, so far as his blowing capabilities are concerned.

Of the multitude of different forms of blowpipe none is so well suited to general plumbers and gasfitters' work as the common taper tube, curved to a right angle at the end, with the mouth-plate previously described. It can be used to direct the flame either to the right or left, without the assistance of the hands, and in the most confined and awkward positions. It is a common practice to use with this blow-pipe a tallow candle with a broad wick, but the power of this is not sufficient for many purposes. The advantage of the candle is that it is often useful to obtain a light in dark places. The candle may be very well superseded by a small cup about the size shown in Fig. 2, or a shade larger, packed with slag-wool or asbestos, and covered over the top with wire gauze. Rising from the side is a feather, with a tube on the top, into which the blow-pipe fits tightly. When wanted for use, a few drops of spirits of wine, or a mixture of this and turpentine, must be poured out of a small bottle into the cup and ignited. This then becomes practically a large flame candle, which requires no holding, and therefore sets the hands at liberty, the flame being at the same time larger and more powerful than that of an ordinary candle.

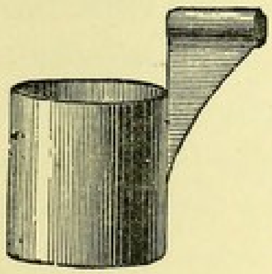


FIG. 2.

For soft soldering, lead, tin, pewter, or Britannia metal, the common plumbers' soft solder, containing about two of lead and one tin, should be used, but for other and less fusible materials, where there is no danger of melting holes in the work, it is better to use pure tin or Britannia metal as a solder.

Workers in Britannia metal commonly use as solder thin strips of the same metal as the body of the work. A workman without experience would at the first attempt melt both work and solder at once, as both would fuse at the same temperature. This, however, can easily be prevented by directing the point of the blowpipe flame only on the solder (as it may be called), and making a jerking flame by repeatedly closing the blowpipe with the tip of the tongue. This intermittent jerking flame is of the utmost importance in all delicate work, as, by regulating the interval, it is possible to produce and keep an exact temperature, stopping, increasing, and reducing the heat precisely as it is required. By the use of this jerky flame the solder can be kept at exactly the temperature at which it will work in a pasty form, and weld up solid with the body of the work without ever becoming properly fluid.

This process of soldering, as will be seen when hard soldering is treated on, is precisely analogous to the welding of wrought iron; it is in fact a welding process, although commonly called soldering. To assist in shaping and making a neat joint, a blunt metal point (usually steel or iron) is used, whilst the solder is in a pasty state, in the same manner and for the same purpose as a plasterer uses his trowel. Some good workmen affect to despise the plasterers' art as applied to soldering, but usually they find out their mistake, and sooner or later adopt it for many classes of work.

Of fluxes for soft solder there are four in general use. For zinc or iron, hydrochloric (muriatic) acid; for tin, Britannia metal, pewter, brass, &c., the same acid in which bits of zinc have been dissolved until it will take no more. This forms what is known as chloride of zinc, or "killed spirit of salt." Powdered muriate of ammonia (sal-ammoniac) mixed into paste with water, is equally good, and more convenient to carry about, and many of the highly-praised soldering fluids consist of a mixture of the two last-mentioned compounds. Lastly comes common powdered resin, but this is not well suited for use with the blowpipe, and does not allow the solder to run so well and freely.

It will, of course, be understood that in soldering bulky or heavy work the parts of the work near the solder must be made hot enough, so as not to conduct the heat away, or a good joint cannot be obtained

It is, therefore, necessary to have some source of heat more powerful than either a candle or the substitute previously mentioned, and in an equally portable form. The best I know is a lamp

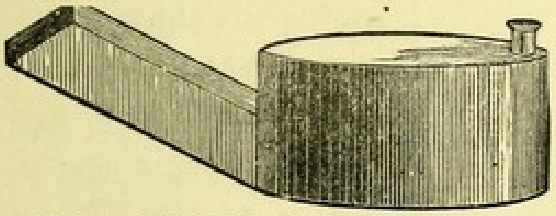


FIG. 3.—LAMP (QUARTER FULL SIZE).

made of tin, of the form illustrated in Fig. 3, in which either spirits of wine, turpentine, or petroleum oil can be used. The wick holder should be made to take five or six thicknesses of soft wick, one inch wide, side by side, so as to form a good body of substance to carry up the fuel freely and make a large flaring flame, as large as can be taken up by a full-sized blowpipe, and the full blowing power available By raising or lowering the wick, the flame may be made larger or smaller as required for the work in hand, and a tin cap will extinguish it when done with.

When a workman has to carry his lamp about, the cap should fit as closely as possible, and a ring or loop should also be soldered underneath the wick tube not far from the end, into which a loop, of chain or cord, is fastened. If the lamp is hung by this to the handle of the tool basket, there need be no fear of a mess, as the open end will always be upwards. The filling hole in the box must always be closed with a screw cap or well-fitting cork.

For odd work, in places difficult of access, a more handy arrangement can be made by dipping strips of soft flat wick in tallow and placing them, whilst the tallow is still soft, in a pile, squeezing them together so as to form a solid mass of wick, saturated with tallow, measuring, say, one inch by half-an-inch in section. These blowpipe candles or torches can be easily and cheaply made in quantities and of any size, and should, when cold, be wrapped in two or three folds of paper which can be torn off close to the burning part as required. The paper serves as a holder, and catches any drip, provided too much tallow has not been used in the manufacture.

Where available, there is no fuel to equal gas for general blowpipe work, and in using the blowpipe already referred to, with gas, it is usual to cut a notch or groove in the upper side of the open end of a three-eighths brass tube, so as to allow the top of the blowpipe to rest in it, pointing in the same direction as the opening in the gas pipe. The blowpipe tip should then be placed in the notch, and a wire bound round both in such a manner that the blowpipe is held firmly in position, and still can be easily drawn out backwards. This arrangement, which is shown in Fig. 4, forms a carrier for the blowpipe, which leaves the hands at liberty, and enables the whole attention to be directed to the work in hand. A short length of tube made like this could be carried in the tool-bag, and connected to any available gas supply.

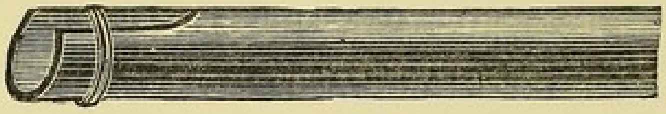


FIG. 4.

For hard soldering, where the solder used melts at a heat approaching redness, and sometimes at a still higher temperature, the same form of blowpipe and the same source of heat are commonly used, except that as the work is usually done in fixed workshops, the sources of heat do not require to be portable, and are therefore usually confined to gas, or, where this is not available, to the lamp previously referred to, the lamp having fixed on the upper side of the wick tube, in a convenient position, a support of wire, or other material, to carry the front of the blowpipe. Sometimes the blowpipe is made as a simple straight tube, sliding in a loose collar, the blowpipe in this case being about three or four inches long. At the opposite end of the jet is fixed about fourteen or sixteen inches of small india-rubber tubing (feeding-bottle tube), which is used for blowing.

The sliding motion of the blowpipe is necessary, so that the jet can either be drawn back giving a larger rough flare for general heating, or it can be pushed into the flame, so as to take up part only and give a finely pointed jet on any part where the solder requires to be fused.

When gas is used, the sliding motion of the blowpipe is not necessary, as the flame can be altered equally well by the gas tap, and it is therefore usual to make gas blowpipes with fixed jets, such as are shown in the engravings.

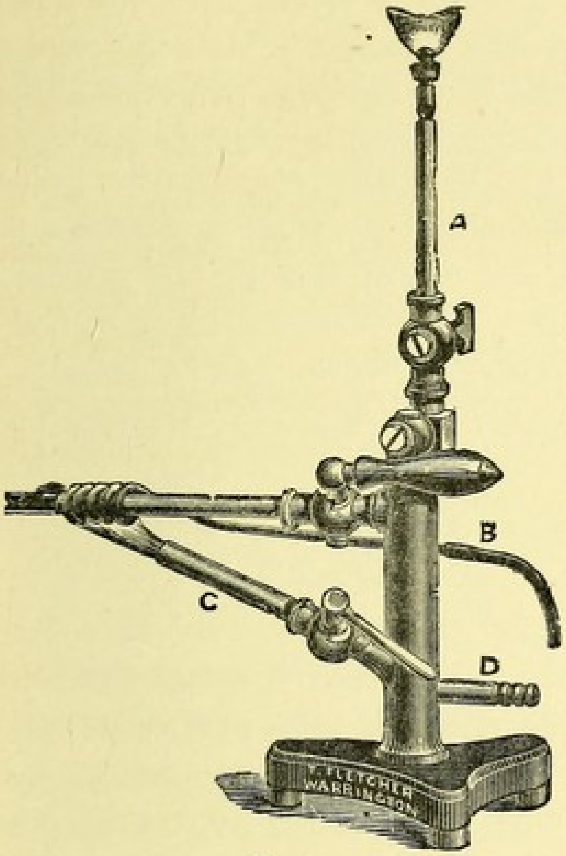


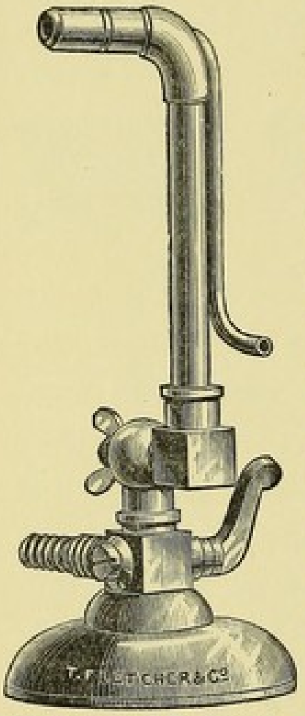
Fig. 5.

In Fig. 5 the blowpipe is coiled as a spiral round the gas tube, and both gas and air are heated before burning by a Bunsen burner underneath, giving a very much greater power for small work.

It has proved, however, contrary to my expectation when I devised this form of blowpipe ten years ago, that the hot blast is no advantage whatever for large flames. On the contrary, when the maximum bulk of work is to be heated with a mouth blowpipe, a better result is obtained with a cold blast of air, and the advantage of the hot blast is only perceived when a small pointed flame is used. When this blowpipe is used for soldering, the bulk of the work should be heated up first with the cold blast, and the lower Bunsen turned on a few seconds before the small pointed flame is required for finishing the soldering.

There is probably not one maker of scientific apparatus in the world who has not copied this blowpipe, and it has been sold in large quantities, but many have bought it in ignorance of its peculiarities, and have been disappointed in not obtaining a higher power for large work than can be obtained with the common blowpipe. The hot blast has one advantage peculiar to itself in addition to the high temperature of the small flame: it requires no chamber for condensed moisture. The moisture of the breath, instead of appearing as occasional splashes of wet on the work, at critical times, is converted into steam, and goes to assist the blast from the lungs.

The fluxes usel for hard soldering may practically be reduced to one, *i.e.*, borax. No other is of sufficient general advantage to be worth mentioning.


JEWELLERS' PATTERN.

For brazing, where powdered or grain spelter (a very fusible brass) is used, the borax is mixed as a powder with the spelter, usually with a little water, but sometimes the work to be brazed is made hot and dipped into the dry powder mixture which partially fuses and adheres. In either case, care is requisite not to burn or oxidise the grains of the spelter with the blowpipe flame, or it will not run or adhere to the surface to be brazed; and for such small work as can be done with the mouth blowpipe it is better to discard spelter entirely and use either common silver solder, which is an alloy of one silver and two of tinned brass pins, or what is still better, an alloy of thirteen parts copper and eleven parts fine silver. If fine silver is not easily to be got the same alloy can be made by equal weights of copper and coin silver.

The solder should be rolled into thin sheets, cut into small bits of the shapes and sizes required, and put into a small saucer, containing a rather thin pasty mixture of powdered borax and water. The surfaces of the joint to be soldered should be brushed with this mixture, using a small camel-hair brush, the bit of solder being put in its position either with the brush or a fine pair of tweezers.

The heat of the blowpipe must then be applied very slowly. The boxax dries up and swells enormously, frequently lifting the solder along with it. The borax then sinks down again and begins to fuse. There is now no risk of blowing the solder away, and the full blast can be at once applied, directing the flame principally round the solder so as to heat the body of the work. When hot enough, the solder begins to fuse and adhere to the work, and the flame must now be instantly reduced to a small point, and directed on the solder only, which usually fuses suddenly. The instant the solder runs, the blast must be stopped with the tip of the tongue, or in delicate work mischief may be done which may take hours to make good. One great difficulty with beginners is in soldering two or more parts in exact positions relatively to each other, these parts being of such a form that they cannot be held in position.

The way to overcome the difficulty is this: With a stick of beeswax, the end of which has been melted in a small flame, stick the parts together as required. The wax is sufficiently soft when cold to admit of the most exact adjustment of parts, and it must surround the parts only which are to be soldered. Make a mixture of about equal parts of plaster-of-paris and clean sand, and stir this up in a cup or basin with sufficient water to make a paste, turn it out on to a sheet of paper, and bed the work to be soldered into it, taking care that the part covered with wax shall be freely exposed.

When this is set hard, say in about ten minutes, slowly warm it over a Bunsen flame, or near a fire (if suddenly heated it will break up); wipe the melted wax off with a small ball of wool; apply the borax, and solder as before mentioned, and continue the slow heating up until the whole mass is hot enough to complete the soldering with the blowpipe.

If a light bit only has to be carried or held in position after fixing with wax, as before mentioned, a bridge or arm may be made between the two pieces with a very stiff paste made of common whiting and water, or a mixture of clay, whiting, and water. This being only small in bulk, dries much more quickly than the plaster and sand, but it requires also very slow heating at first, so as to drive out the moisture gradually, otherwise it explodes as steam is formed inside, and the whole work has to be recommenced.

The Indian jewellers in making filagree work use clay alone for holding the parts together, but it is very slow in drying, and requires much more care in use than either of the forms given.

When soldering, the work has to be supported in such a manner that it can be turned about and its positions altered quickly, more especially when a fixed blowpipe is used, and for this purpose it is common to use either a lump of pumice-stone or a small sheet-iron pan with a handle, and filled with broken lumps of pumice, broken charcoal, and plaster-of-paris, or other non-conductor. The best material is willow charcoal, and the best result can be obtained by its use, as, burning with the heat of the blowpipe, it gives off heat and assists the workman, giving a greater power than when any support is used. Oak charcoal is not admissible, as it crackles and disturbs the work. For a permanent support, which does not burn away to any practical extent, the best is a mixture of finely-powdered willow charcoal and a little china clay, made into a stiff paste with a rice-flour starch, and rammed into a mould. These are to be bought in many shapes, and are the most convenient for all purposes.

The receipts for making gold solders will be found in books treating specially on gold working. As a rule, the alloy, or rubbish which is commonly sold as gold, can hardly be safely soldered with anything much better than common soft solder, and it is not safe for an amateur to attempt to repair any of the so-called gold jewellery which sometimes contains the large proportion of one of gold to two or three of alloy, and in addition is often weighted inside with pewter, lead, or something of the kind equally unsatisfactory to the purchaser when he discovers it by the total collapse of his cherished ornament.

Speaking generally of the mouth-blowpipe, the most practised users, as a maximum feat, might, with gas, soft solder a three-inch lead pipe, or with a lamp, do the same with a one-and-a-half-inch pipe. In hard soldering (with silver solder or spelter), it is usually as much as can be done to solder properly any work weighing over three ounces, if gas is used; or about half this weight with a lamp; although in exceptional cases, using a charcoal support, these weights may be exceeded, and more especially if the bulk of the work is heated up by a fire, or other means, so as to admit of an extra strain being put on the lungs for a short time for finishing only. It is a common practice for heavy or awkwardly-shaped work—where the heat is liable to be conducted away quickly—to support the work on a bed of burning coke or charcoal, using the blowpipe only for running the solder, whilst the body of metal is heated by the burning coke. By this assistance the capacity of any blowpipe is doubled, or more than doubled, and when work is to be done beyond the capacity of the blowpipes available, this remedy is a valuable one.

When the work exceeds the capacity of the mouth blowpipe, or when it is too continuous to be done with the mouth alone, a mechanical blower must be used, and the selection of this to suit the work required is a matter of considerable importance.

As before stated, the temperature of a given flame, the fuel combustion being equal, is greater in inverse proportion to its size. The smaller a flame becomes, when the air blast is applied, the hotter it is, and the more work it will do, provided the air is not supplied in excessive quantity.

Other things being equal, a high pressure blast gives the most powerful flame, and the pressure of the air supplied is therefore a matter of serious importance.

An average adult can, with an effort, give an air pressure in a blowpipe equal to about 36 inches of water pressure, or one and a half pounds on the square inch. The average pressure is, however, about half this, or rather less, the maximum being only obtained by a severe strain, which cannot be continued.

A fan worked by the foot will give an air pressure equal to about half-inch to one inch of water.

A fan worked by power will give air at from one to five inches of water pressure, depending on its speed and construction.

An average smiths' bellows about 5in. pressure.
Small heavily-weighted circular bellows about 8 to 10in. pressure.
Root's blower driven by power 24in. pressure.
Fletcher's foot blower No. 2, 15in. pressure.
Fletcher's foot blower Nos. 3 and 5, 30in. pressure.
Fletcher's foot blower No. 4, 45in. pressure.
Cotton and Johnson's foot blower (variable), 5 to 20in. pressure.

The temperature of a blowpipe flame may be estimated from the above, being in close proportion to the pressure of air supplied, and it may be taken as a rough rule in brazing or hard soldering with gas, that, given an air pressure equal to about 15in. of water, a blowpipe, having an air jet of $\frac{1}{8}$in. bore, will braze work up to $\frac{1}{2}$lb. total weight. One with an air jet of $\frac{1}{4}$in. bore, will braze up to about 2lb. total weight, *i.e.*, two brass weights, each 1lb., could be securely brazed together with a blowpipe with $\frac{1}{4}$in. bore air jet, and supplied with air at a pressure equal to 15in. of water, or 10oz. on the square inch. It will, of course, be remembered that the areas given are those of the air jet or point at which the blast leaves the blowpipe, and the area of the gas supply is that of the space between the air tube and the gas tube outside it. The area of taps and pipes to supply these must, of course, be larger to prevent friction as much as possible. When anything like a high power is required, it is of the first necessity that any elastic or flexible tube used shall be perfectly smooth inside. A length of six or eight feet of india-rubber tube, with wire inside, will reduce a gas supply or a pressure of blast to about one-half. Practically this amounts to requiring apparatus double the size for the same work, and it therefore does not pay to use rough tubing. Applying the rule to other shapes of work, it may be taken that a blowpipe which will braze a block of 2lb. total weight, when the work is supported on a good non-conductor, will braze brass plate up to $\frac{1}{8}$in. or 3-16in. thick. Its capability of brazing iron is not so great, as iron does not take up the heat of the blowpipe so readily as brass does. When the blowpipe is supplemented by either a bed of burning coke or by a non-conducting jacket round the work the power of any blowpipe may be extended almost without limit, as little of the actual work of heating the body of metal is done by the direct blowpipe flame.

In the construction of blowpipes for gas they should be so proportioned as to give the maximum effect for the minimum of fuel and blast. To do this the air pressure available must be an important factor.

Speaking roughly, but still sufficiently near to make a correct rule to work by, a blowpipe requires one of gas to eight of air. If the gas is supplied at a pressure equal to one inch of water, and the air at eight times that pressure, the area of the gas and air pipes should be equal to get the best effect. If the air supply is equal to 16 inches of water pressure, the gas pipe must be double the area of the air, and so on in proportion.

Of course the air and gas supplies can be adjusted by taps easily, but in the first construction of a blowpipe for large work, this rule must be adhered to. Any departure from it reduces the power of the blowpipe, and ignorance of this simple rule has frequently caused failures which the makers of blowpipes have been unable to explain.

It is often an advantage to build up a blowpipe quickly for some special work, and the method and rules for construction are here given, bearing in mind always that a high pressure blast gives the most compact and highest temperature flame, without having any actually greater *quantity* of heat in the flame produced.

At day pressure=10-10ths on the gas supply, a half-inch pipe with a half-inch bore tap will supply about $1\frac{1}{4}$ cubic feet per minute, or 75 cubic feet per hour. A one-inch bore pipe and tap will supply about five cubic feet per minute.

About 25 cubic feet of gas equals one pound of coal in fuel value, and, therefore, a half-inch gas pipe will supply at the rate of one pound of coal in a gaseous form in twenty minutes. To burn this in a blowpipe, an air supply of ten cubic feet per minute is required, and given the available blast pressure the area of the air jet necessary is easily found.

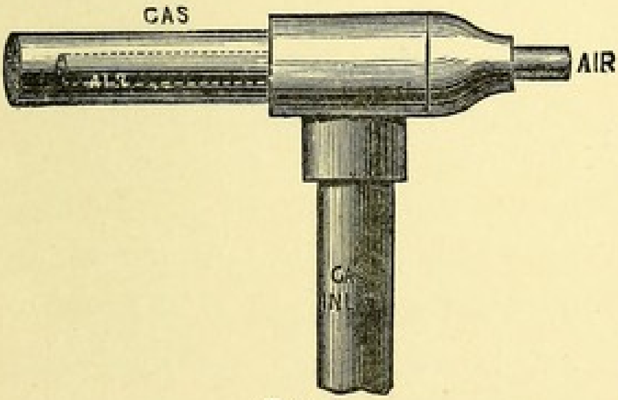


Fig. 7.

For the construction of large blowpipes for special work, the stock fittings can generally be utilized, and an efficient blowpipe built up in a few minutes, as shown in Fig 7. Nothing more is necessary than three short bits of tube, a T coupling and diminishing socket, or straight union. No taps are necessary on the blowpipe, if not at hand, as if an elastic tube is used the flame can be perfectly controlled by squeezing the tubes between the fingers, holding them in the same way as the reins are held in driving a horse. If a diminishing socket is not at hand, the end of the T piece can be plugged up and the air tube fastened into this plug, and it will be a convenience if an elbow is put on the gas inlet close to the T, so as to turn the gas pipe in the same direction as the air pipe. In this form, it makes a handy and convenient blowpipe.

Blowing Apparatus.—For any except very small work, some mechanical blower is absolutely necessary. Those who do not care to go to the expense of any of the apparatus usually sold, can produce a good make-shift with one or two pairs of common house bellows. If an upholsterer's or sofa spring is placed between the handles so as to render the opening of the bellows automatic, the pressure of the foot on the top board will give a strong blast of air. This, although intermittent, acts very well for a large proportion of work, and a full-sized pair of house bellows will supply a blowpipe with an air jet of full $\frac{1}{8}$ or 3-16ths in. bore. A continuous blast, at all events for soldering and brazing, is not at all necessary, unless the maximum possible power is required. To obtain a continuous blast from this arrangement several ways may be adopted. It is of course necessary to have a reservoir, which is always under pressure, and some means must be adopted to prevent the air in the reservoir blowing back into the bellows, whilst they are being lifted between the strokes.

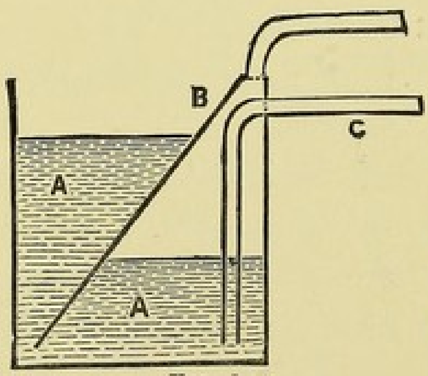


Fig. 8.

If a square tin or zinc vessel is made, with a sloping partition, shown at B (Fig. 8), the partition slightly open at the bottom, and the vessel half filled with water, the air when blown by the bellows through the pipe C, bubbles up through the water, which makes the bottom of the pipe C tight against the return of the air. As the air accumulates in the close part it presses the water A under the partition to the other side, causing a difference in level, which exerts a continued pressure on the air pipe on the top. The deeper this vessel the heavier the air pressure which can be obtained, as this is ruled by the difference in level between the two water surfaces.

This is the only means of getting a continuous pressure without a valve. The next easiest way is to get a second pair of bellows, plug up the hole underneath the inlet valve at the bottom, and in this plug insert a pipe leading from the first pair of bellows. The second pair then forms the reservoir, the air being taken from the nozzle to supply the blowpipe, and the necessary pressure must be obtained by weights on the top board, or by a strong spiral spring fastened to a separate frame above with the lower end of the spring resting on the top board.

The rule with house bellows is that they are made in a wholesale rough way, and very few are anything like air-tight. They should be carefully selected for the purpose by opening fully, stopping the nozzle with the finger, and pressing the handles heavily together. Many will be found to close almost as quickly with the nozzle stopped as with it open, and, of course, these are quite useless for the purpose.

ADVERTISEMENTS.

LIST OF

General Apparatus and Specialities

FOR DENTISTS.

PLASTIC FILLINGS,

PREPARED AND TESTED BY

THOMAS FLETCHER, F.C.S., Thynne Street,

WARRINGTON.

PERFECTED STANDARD AMALGAM, the best for all purposes, in ornamental bottles, ½oz., 12s.; 1 oz., 23s.; 5 oz., 110s.

THE SAME, in envelopes, per ½oz., 10s. 6d.

PLATINUM AND GOLD ALLOY, per oz., 20s.

GLASS PESTLES AND MORTARS, ground inside, 1s. 6d.

PORCELAIN PESTLES AND MORTARS, 9d.

MERCURY BOTTLE, containing sufficient pure mercury for 3 oz. to 4 oz. of filings, 1s.; or with Johnson, Matthey, & Co.'s electrically purified mercury, 2s.

WHITE ENAMEL.—Oxychloride of Zinc, 6s. per packet.

ARTIFICIAL DENTINE.—Oxysulphate of Zinc, 4s. per packet.

PATENT PORCELAIN.—Double Phosphate of Aluminia and Zinc, 6s. per packet.

COLOUR.—For White Fillings. Pink, brown, or blue, 6s. per bottle.

COPAL ETHER VARNISH.—1s. per bottle; 6s. per half-pint.

CARBOLIZED RESIN.—For nerve treatment. 1s. per bottle; 6s. per half-pint.

MIXING TUBE, for amalgams, 6d. each.

CYLINDER MOULD, for amalgams, 9d. each.

DIFFERENTIAL BALANCE, for amalgams, 2s. 6d. each.

The following method of mixing amalgams is so simple, and so faultless in every point, that every dentist is most urgently desired to use it exclusively:—

To use this method weigh with the new differential balance, the proportions re-

Price 2s. 6d.

quired by putting mercury in the cup E.P. for the Extra Plastic Amalgam, or in the cup P.L. for the Platinum Amalgam, then pouring filings into the cup F. until the mercury is balanced.

F.—E.P. give 3 filings to 1 mercury (extra Plastic).

F.—P.L. give 4 filings to 1 mercury (Platinum).

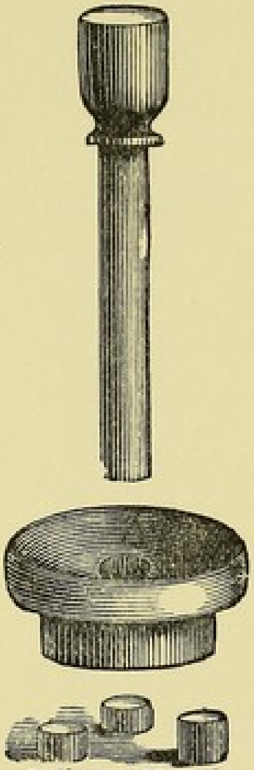
Put the finger over the mercury, pour the filings into the mixing tube, then the mercury, and shake briskly for a few seconds, covering the open end of the tube with the finger.

The resulting mass is in the best possible form for working into discs, with the cylinder mould.

Mixing Tube, full size, Price 3d.

Fletcher's New Mercury Bottle, containing sufficient pure mercury for 3 to 4 oz. of filings, 1s.; or with Johnson, Matthey, and Co.'s mercury (electrically purified), 2s.

Mercury Bottle, full size.



Cylinder Mould,
Price 8d.

Balance mixing tube, and ebony cylinder mould complete, free by post 3s. 6d.

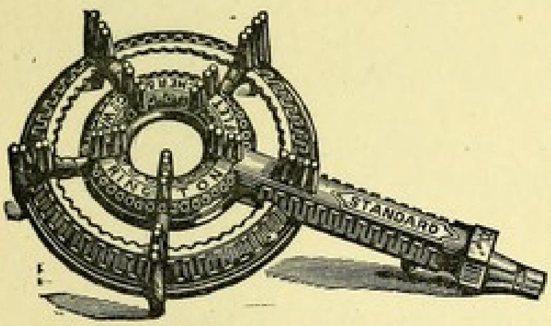
Any alloy is greatly improved in its working by this method of mixing, and perfectly uniform results are obtained with the greatest ease. Less mercury is required to obtain firm cylinders, and all is taken up with uniformity throughout the fillings, which is *not the case with any other process of mixing known at present.*

With ordinary scales the weighing of proportions is a nuisance, but the little balance does all required in the simplest way without the use of weights and with practically no trouble.

This process of mixing is now invariably used in my daily ingot testing, in which plugs of about half-inch cube are made with my amalgams, absolutely and permanently tight to the extreme edge against the most penetrating dyes, and I will undertake to make in the mouth the largest plugs equally perfect in cavities either WET OR DRY.

FLETCHER'S STANDARD BOILING BURNERS.

NEW SERIES. REGISTERED.

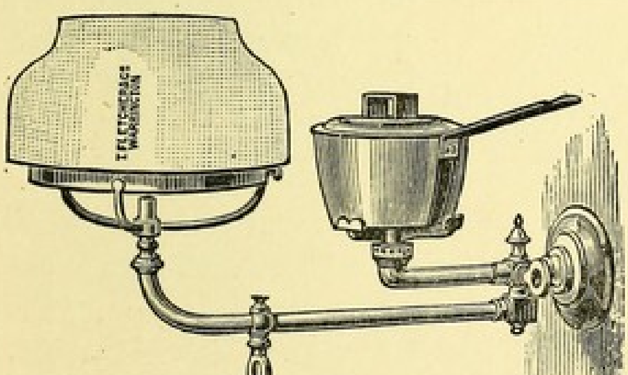


These Burners are designed as a complete series of the highest and most perfect class, in the simplest possible form, and in one single casting. The support for vessels is broad, strong, and steady, carrying all vessels, from the smallest to the largest. The burners are perfect in every detail of form and construction, and they are offered as examples of the best burners which it is possible to construct for ordinary boiling and domestic use.

The numbers give approximately the maximum gas consumption at day pressure of gas equal to $\frac{10}{10}$, and also the number of quarts of water boiled in one hour in a light broad-bottomed copper vessel.

			Price.		Diameter across support for vessels.
No. 10	Standard	...	**1s. 10d.**	...	**5½in.**
,, **15**	,,	...	**2s. 6d.**	...	7 ,,
,, **20**	,,	...	**3s. 9d.**	..	8 ,,
,, **30**	,,	...	**10s. 6d.**	...	10 ,,

No. 30 is two concentric burners with two separate taps. The price includes taps complete for this size.



COMBINED BRACKET FOR LIGHT AND BOILING PURPOSES.

For NURSERIES, BEDROOMS, SURGERIES, &c.

PRICE—

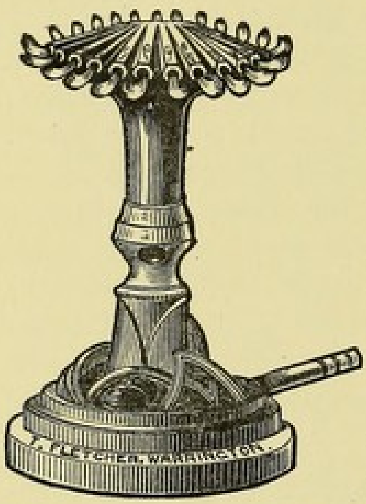
Polished Brass or Steel Bronze, 17s.

Globes and Holders and Pans, extra to order.

Special Patterns in any style of decorative brasswork, for dentists' operating rooms, &c., to order. The boiling burner is a fixture, the light will swivel round on either side.

STAR BURNERS.

For glass flasks, vulcanizers, &c.



No. 6, 3½in. high, will work steadily with any gas supply from 1½ to 6ft. per hour. **Price 2s.** without stand.

No. 8, 3½in. high, will work steadily with any gas supply from 2 to 8ft. per hour. **Price 2s.** without stand.

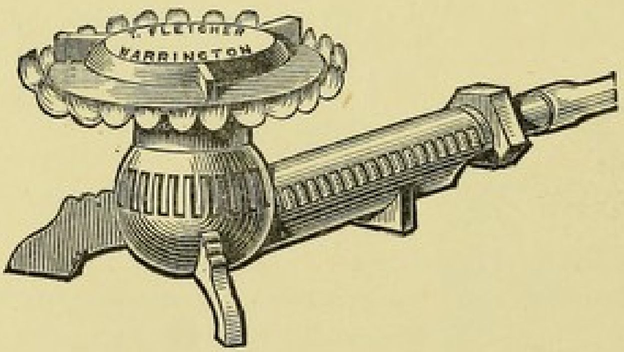
No. 14, 3½in. high, 2 to 14ft. per hour. **Price 2s. 3d.** without stand.

The same burner, mounted on a firm stand, with gas supply pipe, as engraved :—

No. 6 or **No. 8**, 6in. high, **Price 3s. 0d.**
No. 14 ... „ „ **3s. 3d.**

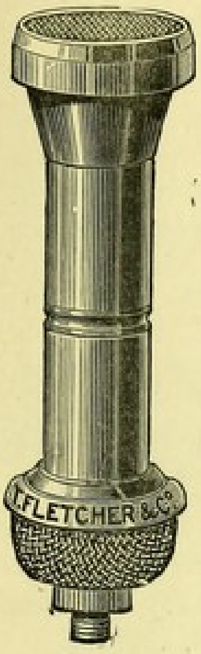
DRIP PROOF STAR BURNER.

This is specially designed for wet, dirty work, such as glue pots, bookbinders' tools, liquids liable to boil over, and places liable to drip. It will burn perfectly under a steady drip of water, and is not interfered with by falling dirt. Will burn steadily with any gas supply from 2 to 14 feet per hour at $\frac{1}{1}\frac{8}{0}$ pressure.



The burner will pass through an opening 3 in. high by 4½ in. wide. **Price 3s. 6d.**

The same burner on upright stand, 6 in. high, **Price 3s. 3d.**



FLETCHER'S PATENT SAFETY BUNSEN.

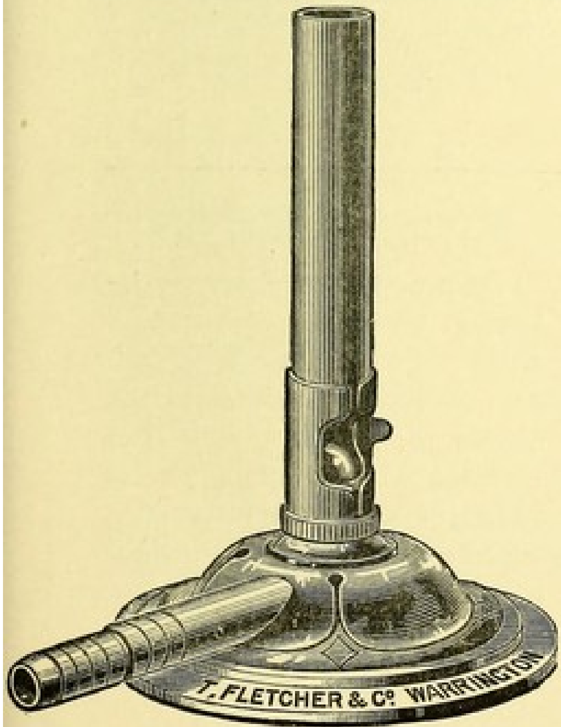
IMPROVED PATTERN.

These will be found as perfect as any upright tube burner can possibly be made, of the highest possible power for the size, can be turned down to the merest flicker without lighting back, and can be mounted on tubes in any form or number when very high powers are required. They are made in three sizes, all in brass, polished. The number gives the maximum gas consumption in cubic feet per hour at $\frac{10}{10}$ pressure. These burners can be supplied in clusters of any number, or mounted on tubes, any shape, and with or without taps, to order.

Number	5	10	14
Diameter across top of gauze... ...	$\frac{7}{8}$in.	$1\frac{1}{4}$in.	$1\frac{1}{2}$in.
Height without stand....	$3\frac{3}{4}$in.	$4\frac{3}{4}$in.	6in.
Price, without stand	**1/9**	**2/3**	**3/-**
Price, on brass tripod stand	**4/-**	**4/6**	**5/9**

If placed a number together, on a tube or ring, they must be at least one-fourth the diameter of the top apart. The stand increases the total height about one inch. The stand is the same as shown below.

SETS.—**No. 10 size.** Each burning 10 cubic feet of gas per hour. Mounted in clusters of four burners (40 ft. per hour), **13/-;** seven burners (70 ft. per hour), **20/-;** twelve burners (120 ft. per hour), **33/6.** Total height, 6 inches.



FLETCHER'S BUNSEN.

These are the ordinary brass tube Bunsen. They are correctly proportioned in every detail, and of the full theoretical power, working up to their maximum calculated duty in every case. All are screwed for $\frac{3}{8}$ connection.

The number gives the maximum gas consumption in cubic feet per hour at $\frac{10}{10}$ pressure.

Number	3	5	6	8	12
Size of tube outside ...	$\frac{3}{8}$in.	$\frac{7}{16}$in.	$\frac{1}{2}$in.	$\frac{5}{8}$in.	$\frac{3}{4}$in.
Height without stand	$3\frac{1}{4}$in.	$4\frac{1}{4}$in.	5in.	6in.	7in.
Price, each without stand	**7d.**	**9d.**	**10d.**	**1/-**	**1/6**
Price on brass stand ..	**2/2**	**2/2**	**2/6**	**3/-**	**4/-**

If fitted with tap, 1s. extra.

All have air slides; these enable the smaller sizes to be used with a blowpipe without the necessity of a loose internal tube.

Heavy round brass stands ONLY are supplied. The objectionable nature of iron stands on a laboratory table is too well known to need any remark. The stand increases the total height about 1 inch. They can be supplied in clusters of 3, 4, 7, or 12 burners, or mounted on tubes, in any form.

FLETCHER'S ARGAND BUNSEN.

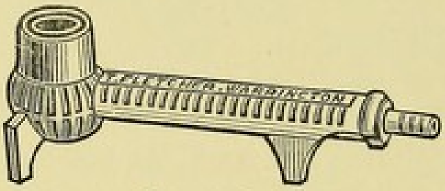


FIG. 200.

A cheap, simple, and indestructible Burner for small laboratory work.

The flame of these Burners is shorter, more compact, and higher in temperature than an ordinary Bunsen, and is also free from smell.

The air supply is self-adjusting.

The sizes given are the bore of the horizontal tube.

Gas consumption.			Price with tripod. Fig 201.	Price without tripod. Fig. 200.
$\frac{1}{2}$in. size	...	$3\frac{1}{2}$ft. per hour ...	3s.	2s. 3d.
$\frac{3}{4}$in. ,,	...	7 ft. ,, ...	3s. 9d.	2s. 9d.

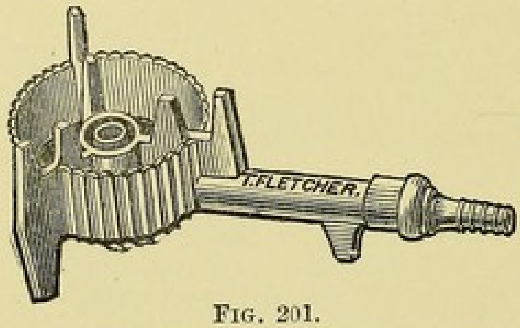
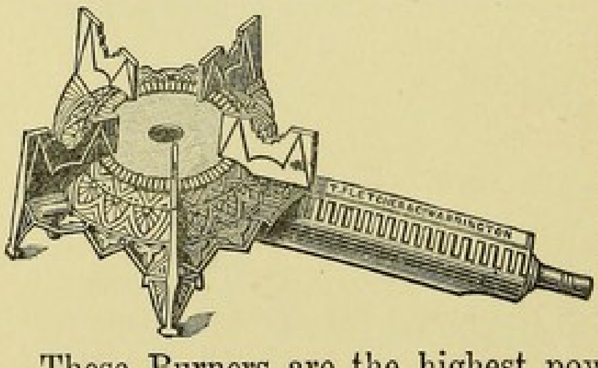


FIG. 201.

All the above work perfectly with Air Gas or Coal Gas, but if the gas is rich, the tip of the brass gas jet may want knocking in a shade smaller. If made too small, the burner lights back.

FLETCHER'S SPECIAL HIGH POWER BURNERS.



On an average it may be taken that three to four cubic feet of gas will boil one gallon of water in an ordinary vessel. The gas consumption of each size is given, and the power can, therefore, be readily calculated.

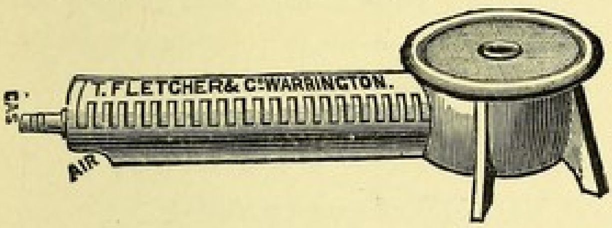
These Burners are the highest power for their size which it is possible to make.

The laws ruling the construction of heating burners, as given in my communication to the Gas Institute, and published in the Transactions for 1883, have been strictly adhered to in these burners, which, for their size, are unapproached in power by any burners in existence.

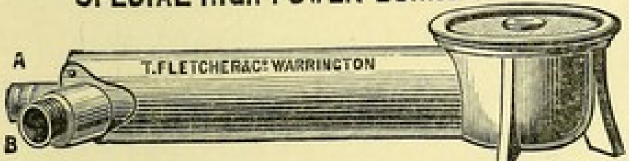
The 4-in. burner, which is the one shown in the engraving on page 4, will, with ordinary day pressure of gas, boil one gallon of water in a flat copper vessel in seven minutes, or 10 to 13 gallons per hour.

PRICES.

Size across the Gauze Surface.	Gas Consumption in Cubic Feet.		Price with Iron Gauze.	Price with Pure Nickel Gauze.	Gas pipe required.
2¾in. diameter.	25ft.	per hour.	6/-	7/-	⅜in. clear bore.
4in. ,,	40ft.	,,	8/-	9/6	½in. ,,
6in. ,,	90ft. to 100ft.	,,	12/6	17/-	¾in. ,,
8in. ,,	200ft. to 250ft.	,,	26/-	34/-	1in. or 1¼in.



SPECIAL HIGH POWER BURNER



SHEWING ATTACHMENT B WHEN USED WITH A BLAST OF AIR

The 6in. and 8in. sizes have no tripod or support for vessels, as the Burners are too small to carry the vessels they will heat. (See engraving.)

An extra pattern of these burners is also made in all sizes to work with or without a blast of air. For working with ordinary gas pressure the gas must be connected to the jet A facing the centre of the tube. When a blast of air is used the air must be connected to this jet and the gas to the side nozzle.

All the following are without tripod.

Size of burner across gauze surface.	Gas consumption without blast at full power.	Gas main required without blast.	Gas consumption with blast at full power.	Gas main required with blast.	Price without blast arrangement.	Price of combined form to be used with or without blast.	If with pure nickle gauze, extra.
in.	ft. ℔ hour	in.	ft. ℔ hour.	in.	s. d.	s. d.	s. d.
2¾	25 ...	⅜	180 ...	1	4 0	6 0	2 0
4	40 ...	½	280 ...	1½	6 3	9 0	3 0
6	90 ...	¾	650 ...	2	12 6	20 0	4 6
8	200	... 1 to 1½	1,400 ...	3	26 0	34 0	8 0

By enlarging the air jet the power may be increased very considerably, but in this case the burners cannot be used with the ordinary pressure of gas without a blast. The 6-inch high power burner will melt 1 cwt. of lead in 50 minutes without a blast, or with a blast of air the 4-inch burner will melt 1 cwt. in about 15 minutes.

INDESTRUCTIBLE GAUZE FOR HIGH POWER AND OTHER BURNERS.

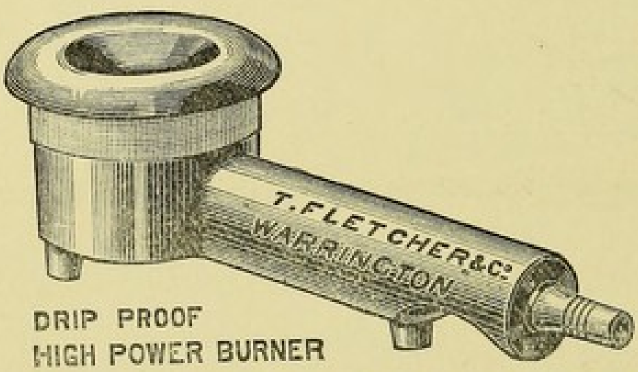
We are now prepared to supply Pure Metallic Nickel Gauze, practically infusible and indestructible, at the following charges :—

	EACH GAUZE.
No. 5, Safety Bunsen...	3d.
No. 10 „ „	4d.
No. 14 „ „	5d.
No. 3, High Power	2 -
No. 4 „ „	3/-
No. 6 „ „	4/6
No. 8	8/-
Low Temperature Burner	3/-

These will be found in every respect equal to pure Platinum Gauzes, at about one-tenth the cost. One Gauze will last on any burner for years in continual daily hard use in the dirtiest work.

DRIP PROOF HIGH POWER BURNERS,

With PURE SOLID NICKEL flame surfaces.



DRIP PROOF
HIGH POWER BURNER

These are undamaged by the dirtiest work, and will burn perfectly under a constant drip. The nickel flame surface adds considerably to the first cost of the burner, but it is practically everlasting, and will neither rust nor burn away.

No. 25, burning 25 cubic feet of gas per hour. This requires a ½in. clear bore gas supply pipe. **Price 6s. 3d.**

No. 40, burning 40 cubic feet per hour. Requires a ⅝in. bore gas pipe. **Price 11s.**

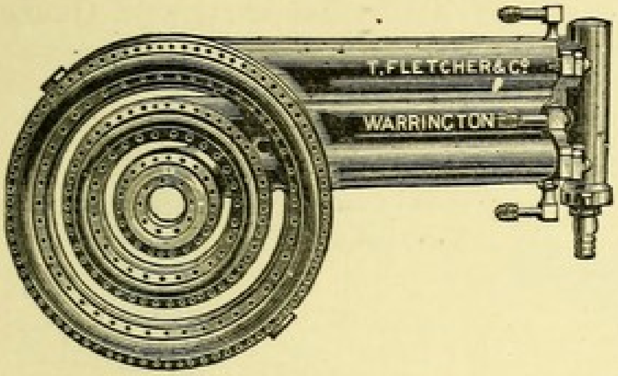
No. 60, burning 60 cubic feet per hour. Requires a ¾in. bore gas supply. **Price 18s.**

No. 90, burning 90 cubic feet per hour. Requires a ¾in. bore gas pipe. **Price 21s.**

No. 200 burns 200 cubic feet per hour. Requires a 1in. clear bore gas supply. **Price 37s. 6d.**

These burners are generally used under vessels either fixed or supported on wrought-iron stands. The burners themselves are very small in proportion to the power and the size of vessel they will heat. The bottom of the vessel should be about 1½ inches clear above the top of the burner.

NEW TRIPLE CONCENTRIC BURNERS.



This is 8½in. extreme diameter, and the three burners are in one single substantial casting. It has been designed as the most powerful concentric ring burner which it is possible to produce, giving, at command, exact powers and exact sizes of flames.

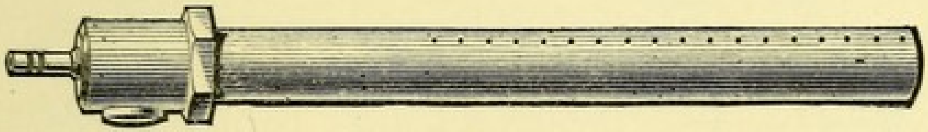
Gas consumption at $\frac{18}{10}$ pressure.

Centre ring, 9 cubic ft. per hour. Middle ring, 20 cubic ft. per hour.

Outer ring, 24 cubic ft. per hour.

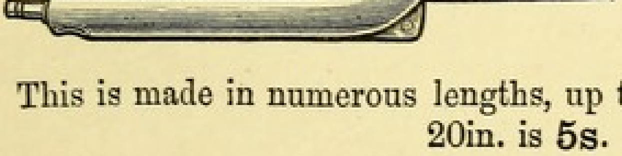
The 3 combined, 53 cubic feet per hour.

Price, as engraved, **30s.**, or with separate tripod Stand, **6s.** extra.



Wrought iron tube burners, straight or curved, any length and any power, without limit, with or without blast. If necessary, tube burners can be made with a perfectly equal and uniform flame, 15 feet long, or upwards.

For all special burners the maximum power, the exact work to be done, or the gas consumption must be specified. The maximum power is quite independent of the length of flame.



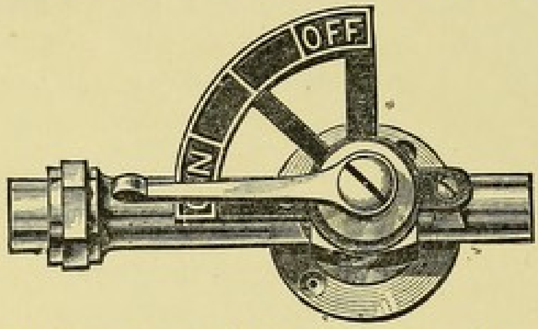
B 24.—Pattern with separate jets.

This is made in numerous lengths, up to 20in. The price of the 20in. is **5s.**

Smaller sizes in proportion.

SPECIAL TAPS FOR GAS HEATING APPLIANCES.

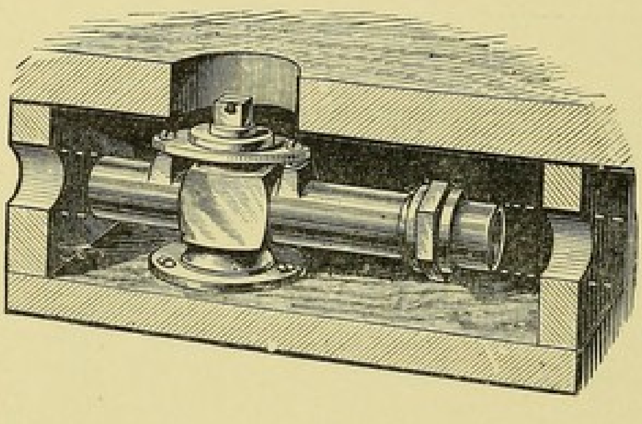
These taps have a full bore in the plug and barrel, are thoroughly well made and finished, and in case of repairs or cleaning can be taken apart from the front or upper side, so that they may be fixed in recesses or wall boxes without risk. Anything which can possibly happen to a tap can be made good without disturbing any joint, a matter of great importance when fixed in plaster or brick walls or under floors



The taps are of the finest workmanship throughout. All are made with screw union.

QUADRANT TAPS WITH LEVER AND GRADUATED ARM.

Size ...	$\frac{3}{8}$in. ...	$\frac{1}{2}$in. ...	$\frac{5}{8}$in. ...	$\frac{3}{4}$in. ...	1in.
Price	**3/6** ...	**4/6** ...	**7/-** ...	**8/-** ...	**10/6**



TAPS WITH KEY FOR SETTING IN RECESSES OR UNDER FLOORS.

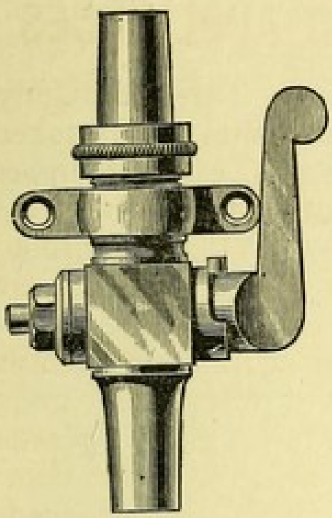
(AS ENGRAVED.)

Sizes and prices same as above. These taps are supplied with brass key complete.

GAS SUPPLY TAPS, SUITABLE FOR RUBBER TUBE, SCREWED JOINTS, OR SOLDERING.

Fig. 113, to obtain a supply from an ordinary bracket. The engraving shows a bracket with and without the attachment.

Price of the attachment only : $\frac{3}{8}$in. size, **3/6** ; $\frac{1}{2}$in., **4/-**.



MAIN SUPPLY TAP,
As engraved.

For ½ inch pipe, 3/-
For ¾ ,, 5/-

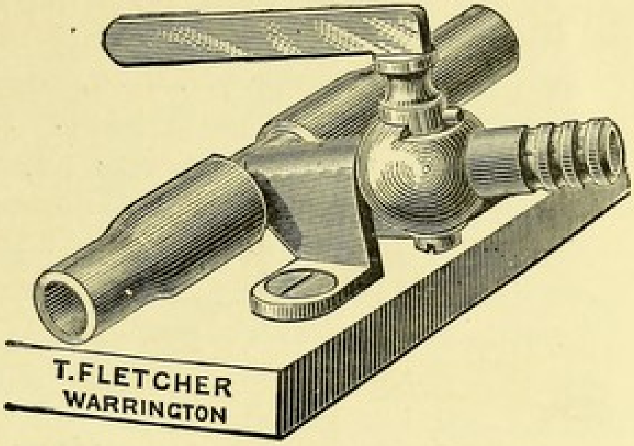


Fig. 112.

To obtain a side supply from the middle of a pipe.

⅜in. size only, 2/-

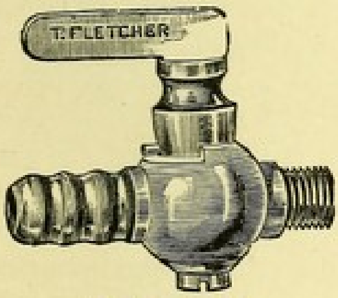
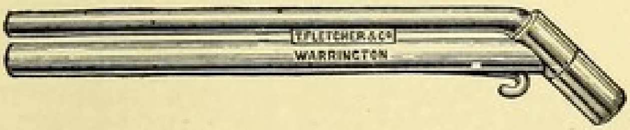


Fig. 114.

Screw.	Bore.	Price.
⅜in. brass gas ...	¼in. ...	1/-
¼in. iron ,, ...	⅜in. ...	1/4
⅝in. brass ,, ...	½in. ...	2/-
½in. iron ,, ...	½in. ...	2/4

FLETCHER'S NEW OXYGEN BLOWPIPE.

FOR USE WITH BRIN'S COMPRESSED OXYGEN.



These are made in three sizes.

No. 7 requires about 7 cubic feet of oxygen per hour, and ¼in. gas supply, and will fuse a ¼in. wrought iron rod easily. **Price 6s.**

No. 20 requires about 20 cubic feet of oxygen per hour, and ⅜in. gas supply, will fuse ½in. wrought-iron rod, and will rapidly braze copper boilers and pipes ⅛in. thick. **Price 8s.**

No. 40 requires about 40 cubic feet of oxygen per hour, and ½in. gas supply pipe; will fuse a clean hole in one minute through a 4in. wrought-iron steam pipe ¼in. thick, and will braze work rapidly of considerably greater weight than this. **Price 10s.**

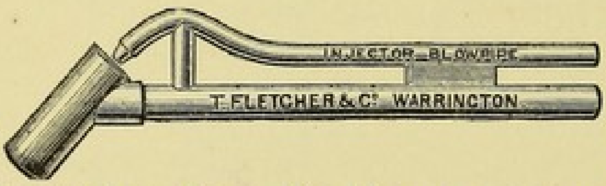
The compressed oxygen may be obtained from the Brin Oxygen Company, Horseferry Road, Westminster, London.

Repairs of Machinery in difficult positions can be done with a small bottle of oxygen and these blowpipes, with a small supply of ordinary coal gas, with the greatest ease.

NOTE.—These blowpipes are totally useless for coal gas and air; they are specially designed for use with compressed oxygen *only*.

FLETCHER'S INJECTOR BLOWPIPE.

FOR HEAVY BRAZING.



This is the most powerful blowpipe made which is light enough to use freely in the hand for difficult work of large size. The engraving shows the blowpipe one quarter full size, and at least a ¾in. clear bore gas pipe and tap are necessary to supply it at full power. With the smallest air jet and **No. 5** Blower it will braze large copper sheets or cylinders, 2½lbs. to square foot, rapidly and easily, and solid work of proportionate weight. With the largest air jet and small heavily weighted smith's bellows it will braze copper up to 2lb. square foot. Two blowpipes used on same work will braze nearly double the weight of metal. The workman's hands are well away from the heat in doing large surface work.

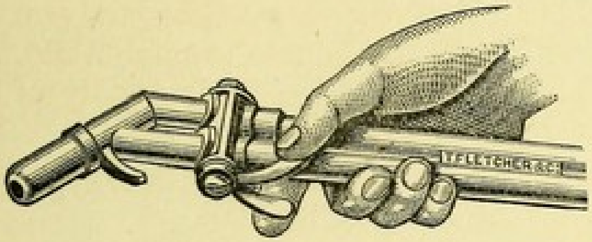
This is the only blowpipe made which can be used satisfactorily on large sheet work without the assistance of a coke fire. It is about double the power of the well-known pattern **8 C.**

Price, with two air jets, **12/-.**

FLETCHER'S NEW AUTOMATIC BLOWPIPE.

PATTERN C.

This will be found a simple and most extraordinarily efficient blowpipe for ordinary workshop use. Both gas and air are controlled with a movement of the finger, a few minutes' practice giving perfect mastery over the character of the flame.



C 10.—Small size, for fine light work, taking air jets not exceeding $\frac{1}{8}$-inch bore. **Price 9s.** The same Blowpipe on Stand, **12s. 6d.**

This requires Foot Blower No. 3 size.

C 40.—Medium size, for small workshop use, key brazing, copper gas pipe up to $\frac{3}{4}$-in., &c., taking air jets not exceeding $\frac{1}{4}$-in. bore. **Price 11s. 6d.** The same Blowpipe on Stand, **17s. 6d.**

This requires Foot Blower No. 5 size, and $\frac{1}{2}$-inch clear bore gas supply pipe.

C 80.—Large size Injector pattern, will braze $\frac{1}{8}$-in. thick flange on $1\frac{1}{2}$-in. wrought-iron pipe and copper cylinders up to 2lbs. square foot. **Price 18s.**

This requires at least $\frac{3}{4}$in. clear bore gas supply, and Foot Blower No. 5 size.

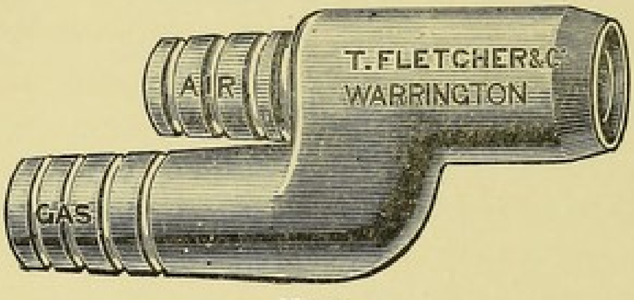
The number gives approximately the gas consumption per hour at full power.

The **PRESSURE OF THE AIR** supplied to any blowpipe rules the temperature of the flame and the power obtained. For a sharp *concentrated* heat a fan is quite useless and smith's bellows nearly so. To get the best work an air pressure of 1 to $1\frac{1}{4}$ lbs. on the square inch is necessary. This can be obtained either with our ordinary foot blowers or with Roots' Blower, driven by power, and except those patterns which are specially designed for fan or smith's bellows the powers specified refer to those obtained with our own foot blowers, which give an air supply at a pressure of $1\frac{1}{4}$ lbs. square inch.

LARGE BLOWPIPES

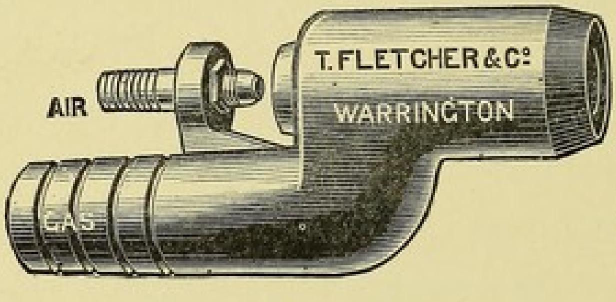
FOR BRAZING, REPAIRING MACHINERY, RETORT AND FURNACE HEATING, &c.

It has been found wasteful and unsatisfactory to use illuminating gas, whatever its quality, for large work, without a blast of air under pressure, owing to the difficulty and uncertainty of making a perfect mixture of air and gas—the usual result being a smoky and unsatisfactory flame of low temperature, giving a very low duty. The following Blowpipes have been made to remove this difficulty, and they will be found exceedingly useful for repairs of pipes and joints, without the necessity of stopping or pulling machines to pieces.



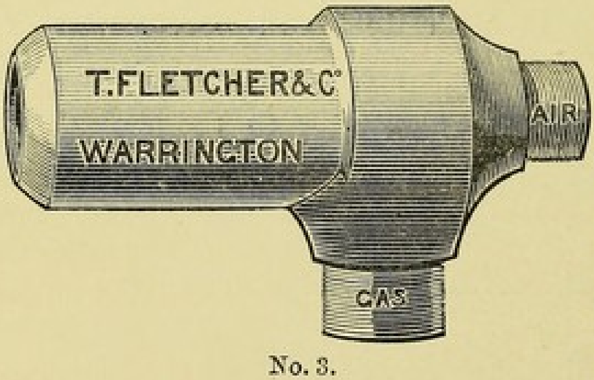
No 1.

No. 1, **Price 6s.**, requires a smith's bellows or good fan and a 1½ inch gas main. It will burn up to 300 cubic feet per hour, and will heat a 3 inch wrought-iron pipe to brazing heat in 5 to 6 minutes. If used under a boiler in series they can be placed side by side at the upper part of the flue, and each burner will give steam for about 4 H. P. indicated in an ordinary boiler.



No. 2.

No. 2, **Price 9s.**, is the same power as No. 1, but can be used with our own foot blower No. 5, enabling it to be taken and used in positions where an ordinary smith's bellows would be a matter of great difficulty. With this a flaw in a pipe can be brazed in any position where it can be seen.

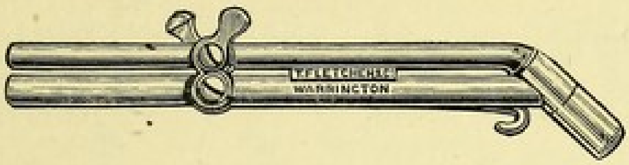


No. 3.

No. 3, **Price 11s.**, is specially adapted for retorts and furnaces, the gas and air pipes being screwed respectively to 2 inch and 1½ inch iron gas thread for permanent couplings. The air jet in this is about double the area of the previous patterns, and with a good fan it has double the power of No. 1.

Gas is in many places now a waste product, which is difficult to utilize, and these blowpipes have been designed to meet a growing necessity.

In reply to many enquiries, petroleum gas and producer gases, although satisfactory for furnaces, are very difficult to use in any open blowpipe for brazing and shop repairs.



NEW PATTERNS OF **Fig. 8 C BLOWPIPE,** with improved control tap arrangement, gas and air supplies independent, and under the control of one finger.

IMPROVED 8 C, SMALL SIZE. **Price 8s. 6d.**

" 8 C, SMALL SIZE, without Taps. **Price 5s.**

For jets not exceeding $\frac{1}{8}$in. bore.

IMPROVED 8 C, LARGE SIZE. **Price 10s. 6d.**

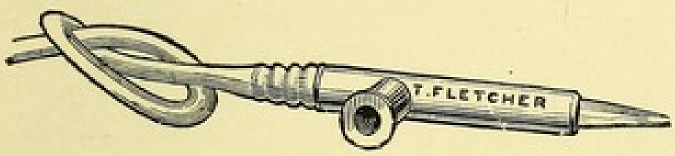
" 8 C, LARGE SIZE, without Taps. **Price 7s.**

This requires $\frac{1}{2}$in. gas supply, and will take jets up to $\frac{1}{4}$in. bore.

This will braze up to 1in. wrought-iron pipe, if used with our Foot Blowers, No. 5 size.

The old pattern is not now supplied.

FLETCHER'S UNIVERSAL BLOWPIPE.



This, in its simplest form, consists of a "head" only, for screwing on a gas pipe, and can be used in any existing arrangement or bracket. The other forms shown are additions and attachments to this, for special purposes, but all are interchangeable. The jets are the same as those used on the Automatic, the smallest pattern taking any jet not exceeding $\frac{1}{8}$in. bore; the largest from $\frac{1}{8}$in. to $\frac{3}{8}$in.

As will be seen, the same blowpipe not only takes a large range of jets, but admits of any and every adaptation which can possibly be required in any trade.

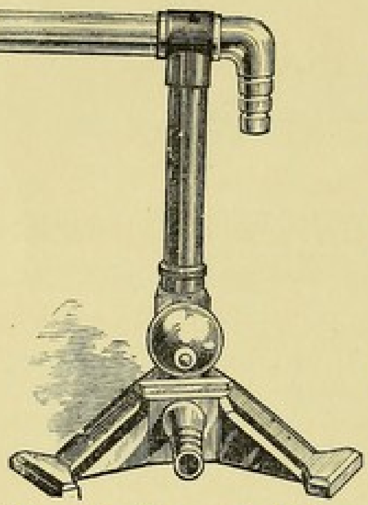
PRICES.

Universal Blowpipe "head" as engraved with straight or bent air inlet.

No. 3.—Price 4s. 6d. Small size, to fit $\frac{3}{8}$ in. brass gas pipe.

No. 5.—Price 5s. 6d. Large " $\frac{3}{4}$ in. " "

(Extra jets **3d.** each.)



UNIVERSAL BLOWPIPE on stand with swivel joint, and with straight or bent air inlet as ordered.

No. 3.—Price 8s. 6d. Small size on stand (as engraved). The same with tap for gas, **10s.**

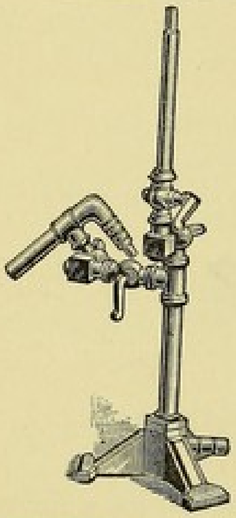
No. 5.—Price 12s. 6d. Large size (as engraved) on stand. This requires a ⅝ in. bore gas supply pipe. The same, with tap for gas, **15s.**

Gas supply required for full power :—

Smallest size blowpipe, ⅜in. pipe.

Large size blowpipe requires ⅝in. clear bore pipe and tap.

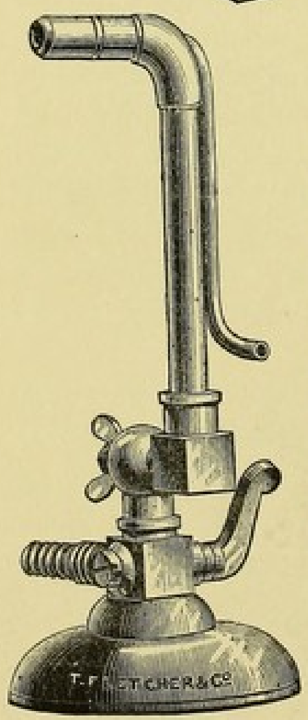
If used with our foot blowers, the smallest size requires No. 3 blower, the large size No. 5.



JEWELLERS' AND DENTISTS' PATTERNS.

No. 3, with bench light and swivelling joint to blowpipe. The bench light swivels down to carry a light to the blowpipe, or *vice versâ*.

Price 16s. 6d.

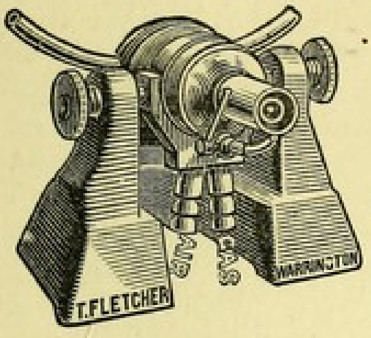


The jet is removable, and any size can be supplied for use with either mouth or foot blower. Total height, eight inches. The flame can be directed at any angle, and can be set firmly by the wing nut shown at the back. The tap lever when pushed backward will turn the light out, when drawn forward will leave a small pilot light. The stand is of brass to prevent rust, and is heavy and perfectly steady.

No. 1, Price 9s. 6d.

Extra jets **3d.** each.

FLETCHER'S COMPOUND BLOWPIPE.



IMPROVED PATTERN.

Price, 60s.

For Glass-workers, and Experimental Laboratories.

(See "Shenstone's Method of Glass Blowing," Rivington's.)

A double concentric blowpipe, the gas and air changing automatically from the larger to the smaller blowpipe by the slight movement of the lever at the back, the same movement also adjusting both gas and air to each other for each blowpipe, giving the fullest and most instantaneous control over the character and size of the flame, without necessitating the use of the hands, the two blowpipes being perfectly concentric.

IMPROVED FORM OF FLETCHER'S ORIGINAL HOT BLAST BLOWPIPE.

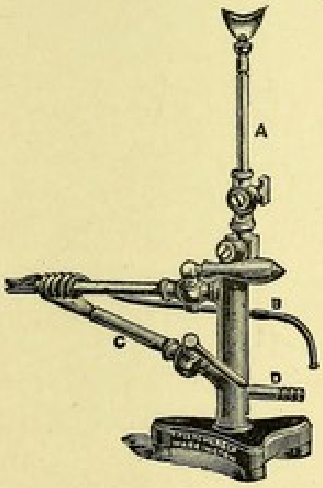


Fig. 1 B., 18s. 6d.

For a large rough flame the Bunsen heater should not be used. The advantage of the hot blast shows only when a pointed flame is required having a high temperature. Duplicate coils and jets, **1s. 6d.**

Same pattern Hot Blast Blowpipe, only without the bench light, **14s.**

SIZES OF BLOWPIPE JETS.

0	1	2	3	4	6	8
•	•	•	•	•	●	●

FOOT BLOWERS.

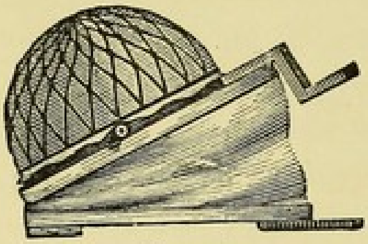


Fig. 9.

THESE ARE THE ONLY FOOT BLOWERS GIVING ABSOLUTELY STEADY AIR PRESSURES IN ALL POSITIONS. No. 3 is the most usual size for blowpipe work, and is generally used for autogenous soldering of lead chambers, being worked by the foot or under the arm as most convenient. No. 5 for the larger injector furnace Fig. 41, and for large blowpipes. All patterns supply the air at a pressure of about 1¼lb. on the square inch.

These blowers have proved themselves to be efficient, simple, strong, and able to stand hard and constant work. The pattern is now made in the following sizes:—

	Size over all, including step and air pipe.	Pressure in inches in water.	Pressure in ounces.	Size of air pipe.
Fig. 9 Size No. 3—Price 21s.	13×10×6½ deep...	30 in...	20 oz. on sq.in...	⅜in.
,, ,, **No. 5—Price 27s.**	15×12×7 ,, ..	30 in...	20 oz. ,,	...⅜in.

Diameter of Air Reservoir, No. 3, 8 inches; No. 5, 10 inches.

Fig. 9 B. Prices—No. 3, 25s. 6d.; No. 5, 30s.

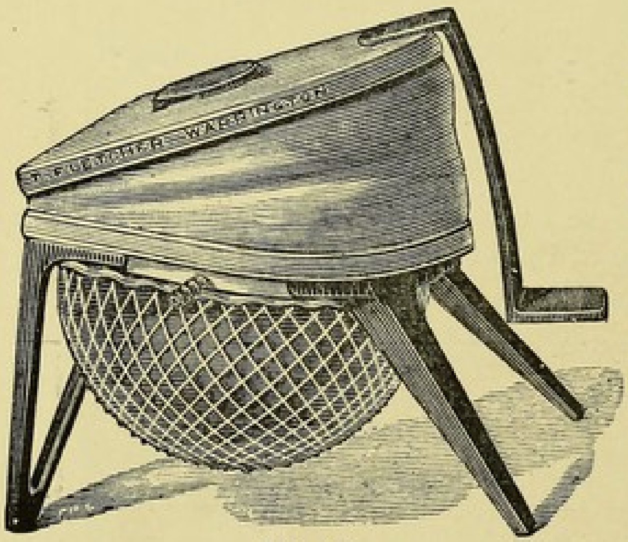


Fig. 9B.

This pattern, by reversing the position of the blower, reduces the risk of mechanical injury to the disc, and does away with the necessity for a wood casing or protection. It also prevents the valve from picking up dirt from the floor, keeping the whole arrangement cleaner, and the valves in more perfect order. Sizes as Fig. 9.

Extra Rubber discs for No. 3, 2s. each; Nets, 1s. For No. 5, 3s.; Nets, 1s.4d.

(2 rubber discs used on each blower.)

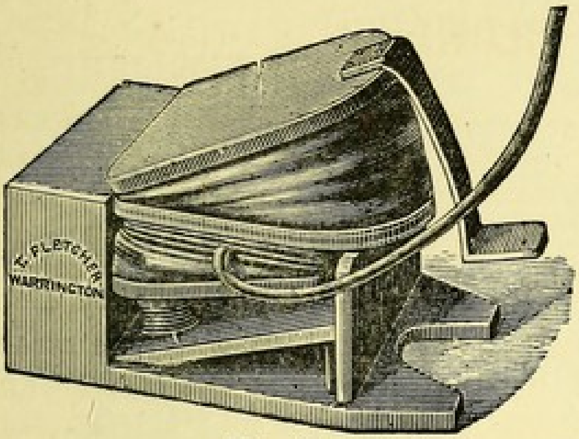


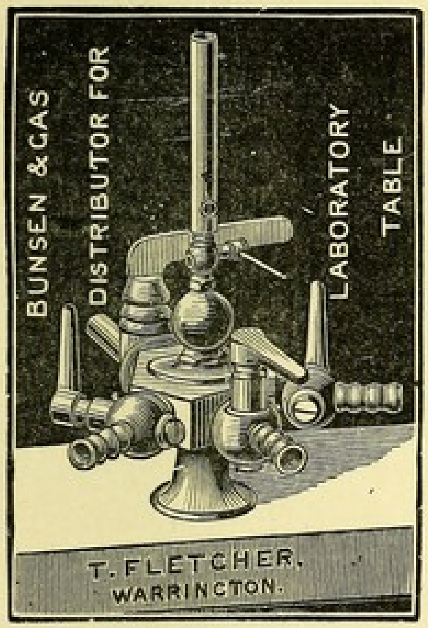
Fig. 9c.

Fig. 9 C.

With spring reservoir in place of india-rubber disc. Fitted for the roughest general use, but not giving steady pressures. Sizes correspond with Fig. 9.

Price, No. 3, 35s.; No. 5, 40s.

Unless for very rough usage, Fig. 9B is recommended in preference for all purposes.

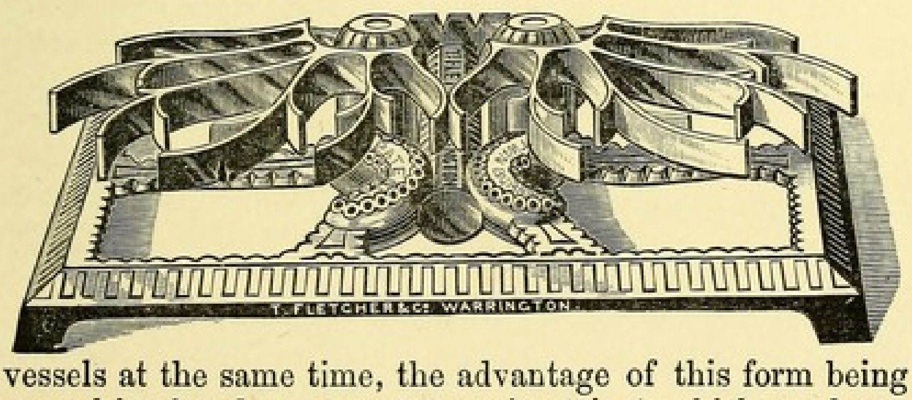


GAS DISTRIBUTOR FOR LABORATORY TABLES.

Price 12s. 6d. This, as shown in the engraving, is a brass pillar, with screwed pipe to pass through the table, taking its supply from underneath. On the top of the pillar is a small jet, which may be either used as a pilot jet for keeping a constant light, or can be converted into a small Bunsen by slipping the tube on, as shown in the engraving. The taps are fitted for rubber tubes, the one engraved having three ⅜in. taps and one ½in.

FLETCHER'S PATENT TWIN TRIVET BURNER.

This is an adaptation of the well-known twin burner for boiling



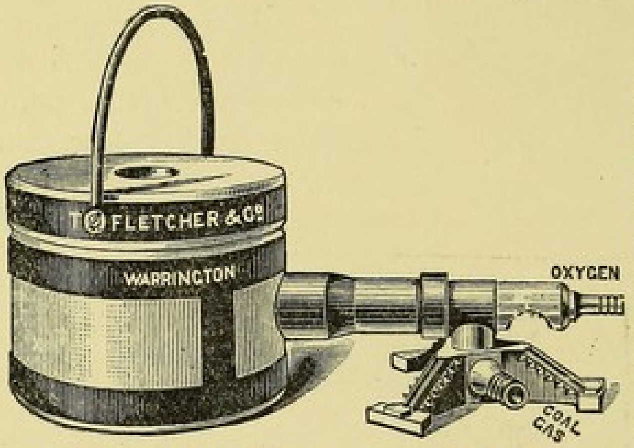
two vessels at the same time, the advantage of this form being that each vessel is placed on a separate swing trivet, which can be pushed over or removed from the flame exactly as required.

Price, 6s. 6d.

FLETCHER'S
COMPRESSED OXYGEN INJECTOR FURNACE,

FOR THE

Rapid Fusion of Metals and the Treatment of Refractory Substances at all Temperatures.



This furnace is entirely self-acting. A very fine jet of Brin's compressed oxygen is first mixed with air, then with coal gas, the pressure of the oxygen being utilized to make this mixture and blow it into the furnace chamber at a high speed.

The quantity of oxygen used depends on the temperature and speed of working required, but under any circumstances is very small for the work done ; and owing to the very large proportion of air used with the oxygen, there is no tendency to local heating or perforation of the crucible. The temperature is under the most perfect control from a red-heat to the almost instantaneous fusion of the most refractory crucibles.

The heat is perfectly steady without any attention ; one oxygen cylinder 2ft. long and 6in. diameter will work the furnace for several hours without any attendance whatever.

The furnace casings are the ordinary well-known Injector pattern, but are lined with a specially refractory material to resist the very high temperatures, which are obtained with the greatest ease. The burner is of the simplest possible construction, and is not liable to damage or to get out of order. We cannot guarantee any casing against fusion if the furnace is worked at its maximum power, nor can we at present guarantee their permanence for frequent use. The price of extra furnace bodies is 4s. ; extra lids, 2s. 6d.

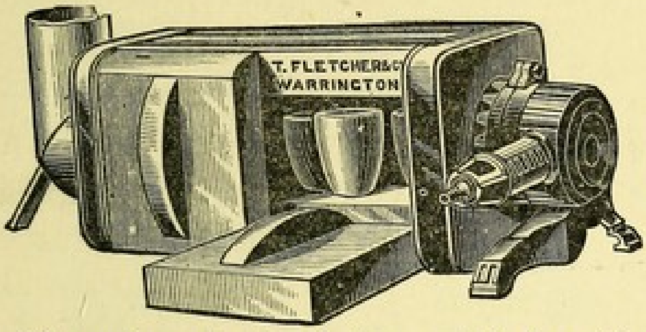
Prices—

Furnace and burner to take Morgan's	00 Crucibles,	**17s. 6d.**
,, ,, ,,	No. 1 ,,	**19s. 0d.**

At present we are unable to make larger sizes owing to the difficulty of obtaining any material which will resist the power of the burner and at the same time retain its shape and stiffness sufficiently to carry any weight of material in the crucible.

FLETCHER'S REVERBERATORY GAS FURNACES,

FOR CRUCIBLES, MUFFLES, CUPELS, &c.



One of these furnaces will do most of the general work of an ordinary laboratory. They work perfectly with chimney draught to a bright red—about the fusing point of fine copper and fine silver. With a blast they will work up to the fusing point of cast-iron. The furnaces can be made to take either two muffles at once, a number of crucibles, trays of cupels, or one muffle and crucibles or cupels at the same time.

The opening may be either at the side or the top, the furnace working either way equally well. The burner is at one end, out of the way of injury in case of accident to a crucible. Crucibles, cupels, &c., stand on the solid bottom of the furnace, perfectly steady and firm. When a blast burner is used a clay collar fits into the larger opening necessary for a draught burner, and the instructions for both draught and blast for the ordinary furnaces apply equally well to this, the burners being identical in principle with those of the previous patterns.

When used with the draught burner the blue cones of flame must be clearly seen on the burner, or if they disappear the gas supply must be increased, or the slide over the burner air tube closed until they reappear. In the latter case the furnace works with a smaller gas supply at a lower temperature, and by closing this slide and reducing the gas supply any temperature required can be obtained. If the adjustment of gas and air is neglected the burner grid becomes red hot and is quickly rendered useless. The grids will last for years if properly used.

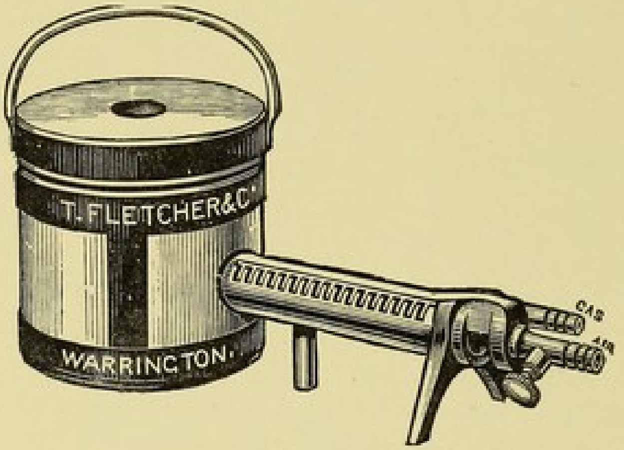
No.	Floor Space in Furnace. Long.	Wide.	High.	Price of Furnace for Crucibles and Cupels.	Notes
1 H ...	14in.	4in.	4in.	**70**/-	Muffle Doors and Stoppers,
23 H ...	14in.	5in.	5in.	**70**/-	8s. each extra.
33 H ...	14in.	5in.	5in.	**80**/-	Burner and Plug for Blast
6 H ...	14in.	6in.	7½in.	**90**/-	arrangement, 10s 6d. extra.

1 H will take Five 2lb. crucibles at once, or 2 muffles about 4½in. wide × 3½in. long × 2½in. high.
23 H will take Two 6lb. crucibles, or 2 muffles—3in. × 4in. × 3in.
33 H ,, Three ,, ,, ,, 4½in. × 4in. × 3in.
6 H ,, Two 12lb. ,, ,, 4½in. × 7in. × 4½in.
6 H requires a special burner when used for muffles or cupels—all the others work with the same burner for both purposes.

In ordering muffles, say if with slits for oxydising or plain for enamels and similar work.

	Clay.	Salamander.		Clay.	Salamander.
Muffle for 1 H ...	1/6 ...	3/-	Muffle for 33 H ...	1/6 ...	3/-
,, 23 H ...	1/3 ...	2/3	,, 6 H ...	1/9 ...	3/6

FLETCHER'S PERFECTED INJECTOR FURNACE.



For Metallurgists, Jewellers, Chemists, Manufacturers of Artificial Gems, and other purposes.

Works equally well with coal gas or air gas.

The small size can be used also with Kerosine or Petroleum Oil. See page 22.

See tests made at the Exhibition of the Glasgow Philosophical Society, October 22nd, 1880.

Power and Speed of Working.—With ½ inch gas pipe and the smallest foot blower, the smallest furnace will melt a crucible full of cast iron scrap in 7 minutes, tool steel in 12 minutes, and nickel in 22 minutes, starting with all cold. With a foot blower No. 5, cast iron can be melted in any furnace up to the 12lb. size. Tool steel or nickel in any up to 6lb. size. Bessemer or gun steel in the smallest size. For higher powers or larger furnaces a Roots' blower, driven by power, is necessary, and the air jet must be enlarged to about double the size, which can be used with a foot blower.

INSTRUCTIONS.

Gas supply required,	6 oz. size furnace,	⅜ in. pipe =	7 to 30 ft.	of gas ℔ hour.
,, ,, ,,	2 lb. size ,,	⅜ in. pipe =	10 to 40 ft.	,,
,, ,, ,,	6 lb. size ,,	½ in. pipe =	25 to 60 ft.	,,
,, ,, ,,	12 lb. size ,,	⅝ in. pipe =	30 to 70 ft.	,,
,, ,, ,,	28 lb. size ,,	1½ in. pipe =	100 to 300 ft.	,,

See that all gas taps have a large clear way through. High temperatures and rapid working require a free supply of gas.

To adjust a new furnace to its highest power for the gas supply available:—

Put the nozzle of the burner tight up against the hole in the side of the casing, turn on the full gas supply, light the gas in the furnace, and commence blowing, *before* putting on the cover of the furnace, with the air way full open. If when the cover is replaced the flame comes out of the hole in the cover about 2 inches, the adjustment is right. If the flame is longer, enlarge the hole in the air jet until the proper flame is obtained, or reduce the gas supply; if smaller, or not visible, screw in the air check until the flame appears.

FOOT BLOWERS. For a gas supply up to 40ft. per hour, blower No. 3 is sufficient; up to 75ft. per hour, blower No. 5. For the 28lb. Furnace, Roots' smallest blower, driven by power. (For blowers, see pages 16 and 17.) Roots' blower is made and supplied by Thwaites Bros., Engineers, Bradford, Yorks.

Keep all fluxes away from the furnace jacket.

Before stopping the blower draw the burner back from the hole. Commence blowing before the lid is put on the furnace.

The blower Fig. 9 is liable to pick up dirt from the floor, throwing it against the gauze of the burner, and stopping the proper working of the furnace until cleared away. A thin layer of silver sand on the bottom will prevent crucibles adhering when at a white or blue heat. Crucibles must be heated very slowly the first time they are used, unless of the "Salamander" brand.

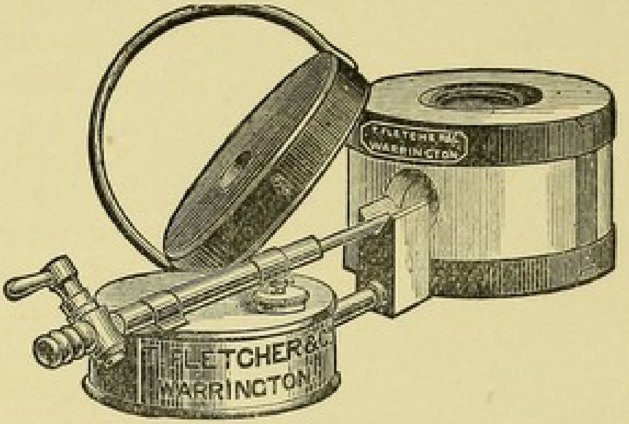
All internally fired casings crack the first time they are used, but should not alter afterwards.

PRICES FOR FURNACES TAKING CRUCIBLES OF THE FOLLOWING SIZES.

Crucibles. No.——☞ (Morgan's.)	00	1	3	6	14
Price of Furnace............	11/6	13/6	21/0	30/0	45/0
Size of Crucibles in inches, outside measure.........	$2 \times 2\frac{1}{4}$	$2\frac{7}{8} \times 2\frac{3}{8}$	$4 \times 3\frac{1}{2}$	$6 \times 4\frac{1}{2}$	$8 \times 6\frac{1}{4}$
Capacity in lbs. iron	$\frac{1}{3}$	2	6	12	28
Foot Blower, Fig. 9b......	25/6	25/6	30/-	30/-	Roots' Blower
India-rubber Tubing	3/0	3/0	4/0	4/0	
Price, complete, ready for use, with blower and tubing	40/0	42/0	60/0	69/0	
Extra Furnace Bodies ...	3/6	4/6	8/6	14/0	20/0
Extra Furnace Lids	2/6	2/6	4/6	7/0	10/0
Crucible Tongs	1/6	1/6	2/0	2/0	
Bow Tongs..................			3/0	4/0	
Crucibles, Fireclay.........	/1½	/2	/5	/10	2/4
,, Salamander ...	/3	/4	1/0	2/0	4/8

For the fusion of pure nickel over 6lbs. at once, a small Roots' blower, driven by power, is necessary, and the air jets of the burners must be enlarged to double the size. The air supply of the 28lb. size must be controlled, if necessary, by a valve or large tap.

OIL FURNACE.

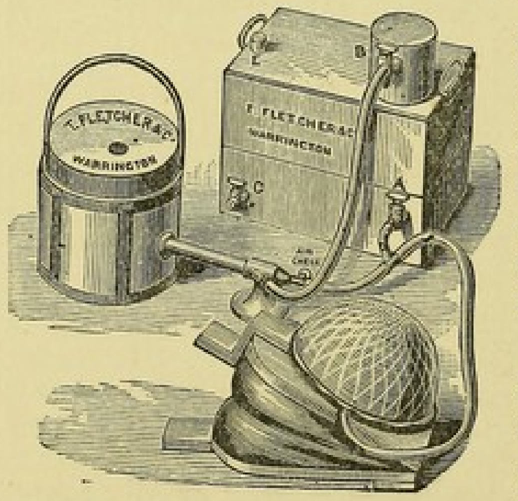


When gas or benzoline is not obtainable, the No. 00 size furnace can be supplied to work with a lamp burning ordinary Kerosine or Petroleum oil. In using this, the wick holder of the lamp must be placed close against the hole in the furnace casing. It is *inferior in power* to the other arrangements, but with a little experience in management, ½lb. of cast-iron can be fused in 12 minutes, starting all cold. **Price of Furnace and Lamp without blower and Tubing, 14s. 6d.** Blower No. 3 is required.

A SIMPLE FURNACE FOR HIGH TEMPERATURES.

(Working with either Gas or Spirit Petroleum, without alteration, and with perfect results with either Fuel.)

The Injector Gas Furnace is also supplied with a small, simple, and perfectly safe arrangement for burning the vapour of gasoline or benzoline, giving a power and efficiency fully equal to that which can be obtained by a large gas supply. The arrangement is in every way as simple as when gas is used, requiring no more trouble or attention. It equals a gas furnace in every respect, and in addition gives a heat of absolute purity, fitting it for the most delicate chemical operations where gas cannot be used owing to the presence of sulphur and other matters.



The ordinary pattern of Injector Furnace is used in precisely the same way as with gas, the only difference being that a branch pipe is taken out of the air supply and connected to the lower tap A on the generator, and a tube is carried from the upper tap B to the side tube of the Injector burner, marked "gas." The quantity of vapour required is adjusted by the lower tap A when the furnace is working, and the flame must be just visible at the hole in the lid, exactly as when gas is used, the instructions being precisely the same for both fuels. To charge the generator, pour benzoline, or gasoline, in the top hole until it overflows at the small tap C in the side, replace the cork firmly, and close the overflow tap. It will then work for about ten to twelve hours at the full power of the Furnace.

Benzoline varies much in quality; it must, when a few drops are poured on a plate or the hand, evaporate quickly and completely, leaving no greasy stain, and if good will produce more vapour than the furnace can burn at its maximum power. All the tubing used must be perfectly smooth inside, or the power of the furnace is greatly reduced.

At the conclusion of an operation close both taps on the generator. It can then be left for any length of time ready for instant use. For ordinary meltings the generator can be used about thirty or forty times without refilling.

The No. 3 size will refine and perfectly fuse 6lbs. of chemically pure nickel, so that it can be poured clean, using an open crucible, a feat beyond the capabilities of any other known furnace.

Benzoline often contains heavy oils. If the generator works badly, empty it and refill with fresh.

PRICES:

Generator only for No. 00 or 1 Injector Furnace, capacity 2lbs. metal, **27s. 6d.**

Generator for No. 3 or No. 6 Furnace, **40s.**

FURNACE, BLOWER, TUBING, AND GENERATOR, complete—

No. 1 size, capacity 2lbs. metal, **75s.** **No. 3 size,** capacity 6lbs. metal, **95s.** **No. 6. size,** capacity 12lbs. metal, **105s.**

The engraving shows the No. 3 size Furnace, Generator, and Blower, as when in use. Scale, 1 inch to the foot. The foot-blower supplied with above is No. 5 (Fig. 9B, page 16). Not the one shown on engraving. The Generator, No. 3 size, will work the 28lb. furnace, provided gasoline is used. If benzoline or spirit petroleum is used, an extra size generator is necessary. **Price, £3 10s.** This size furnace requires a Roots' blower, smallest pattern.

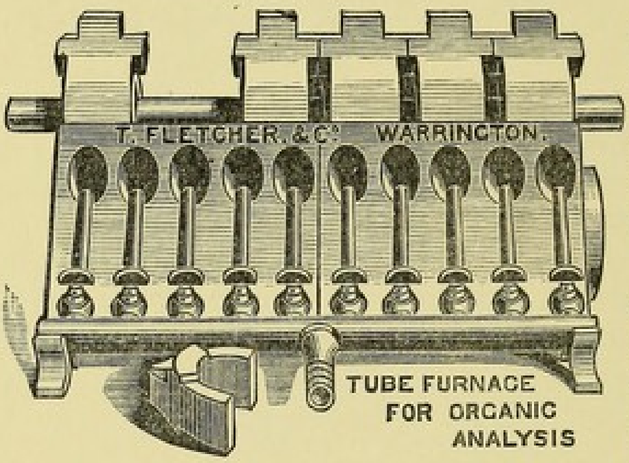
NOTE.—The generator is useless except with a supply of air under pressure. It cannot be used with draught furnaces. If used for blowpipes gasoline is necessary; benzoline or spirit petroleum is little, if any, use for any blowpipes. Gasoline is far inferior to coal gas for blowpipe use.

GAS ENGINES.—The Generators can be used with perfect success for producing gas for engines. For details, see "English Mechanic," December 25th, 1885, Art. 25148, Page 342.

FLETCHER'S TUBE FURNACE FOR ORGANIC ANALYSIS.

No. 2 PATTERN.

The special points about this furnace in which it differs from all others are, the burners are outside and in front of the furnace, and clear from all falling dirt. There is no iron-work to rust, the whole of the metal used being brass.



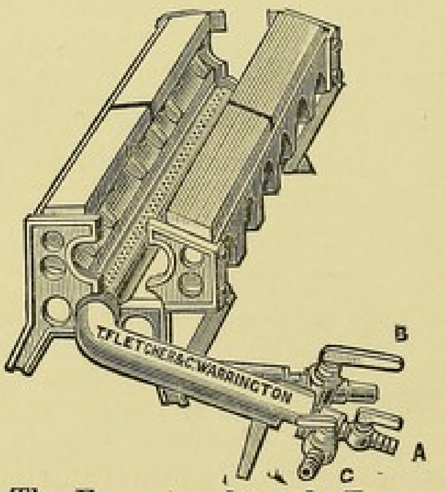
The furnace body is in 6in. sections, and can be made up to any length without any obstruction, such as occurs when a long Hofmann furnace is used with a short tube.

The burners can be made any length, and any part of them used, the blocks and covers are sold separately, and the burners can be supplied in sections of 12, 24, and 36 inches, so that any number can be used in a line without a break, enabling the furnace to be at once built up to any length required.

If a fixed length is required, any number of sections can be fixed permanently together.

It is free from smell in use. In other respects it is similar to the ordinary Hofmann furnace.

PRICE 4s. per inch.



The Engraving shows the Furnace open ready for the introduction of a tube.

FLETCHER'S TUBE FURNACES.

This will heat an iron tube $\frac{3}{4}$ to 1 inch diameter to its softening point in ten minutes, using a small foot-blower; or it will heat the same tube to redness without a blast, the same burner being applicable for either draught or blast.

To use as a Draught Furnace, connect the tap A with the gas supply, closing both the other taps.

As a Blast Furnace, connect B to a second gas supply full ½-inch bore, and connect C to a foot-blower. When the blast is applied the tap A must be closed and the gas supplied only from B. In the pattern with adjustable length of flame, at the side of A, is a screw plug which adjusts the area of the gas jet without affecting the pressure of gas. The gas supply when used without a foot-blower must be adjusted *by this plug only*, and not with the tap, which must be full on. This plug adjusts the gas supply for varying lengths of flame, the length of the flame being altered by a sliding plug in the tube. On the end of a rod carrying the sliding plug is a tap which can be connected to an air supply for the purpose of cooling the part of the tube not exposed to the flame, preventing the heat spreading too rapidly by conduction.

This furnace can be used with air gas or coal gas.

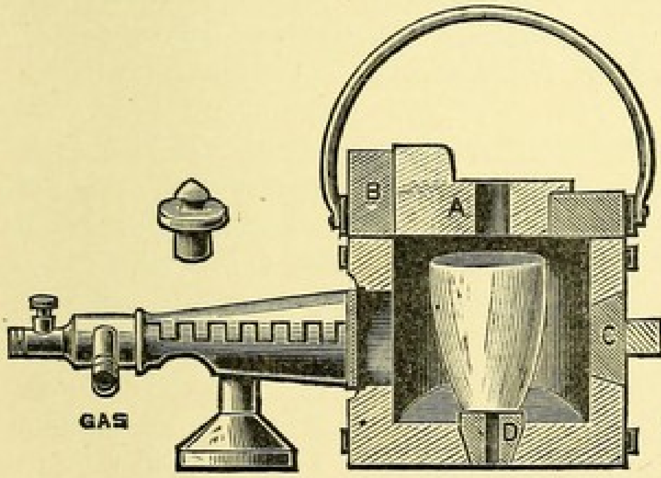
PRICES.	12in.	18in.	24in.
For draught or blast, with adjustable flame length	40s.	42s.	50s.
As above, without adjustable length of flame ...	35s.	37s. 6d.	40s.
With fixed length of flame, without blast	25s.	30s.	34s.

Extra non-conducting blocks, 6 inches long, 1s. 2d. each.

The Foot-blower No. 3, Fig. 9B, is the best for this furnace. Price 25s. 6d.

FLETCHER'S
LECTURE AND EXPERIMENTAL FURNACES.

Price 37s. 6d.

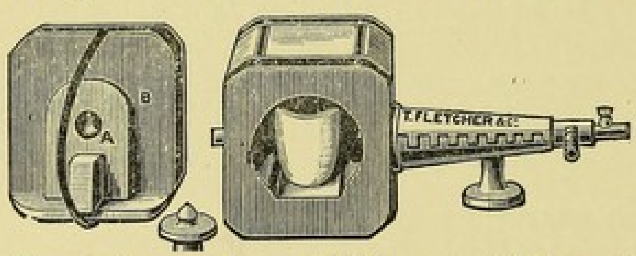


Working with the same burner as a draught or blast furnace at any temperature up to the fusion of the furnace casing, and adapted for Crucibles, Muffles, Tubes, Cupels, distillation by descension, treatment of refractory substances with gases at high temperature, small forgings, roasting ores, &c.

This furnace is specially designed for the lecture table, and has, I believe, power and capabilities equal to any demands which may be made on it. It must be remembered that, although the power of the burner is almost without limit, it is not possible at present to supply any furnace casing which will stand excessively high temperatures, or the contact of fluxes, without damage. Experiments are now being made with more refractory casings, and if it is found possible to produce them commercially, arrangements will at once be made for their production. In the meantime all parts of the casing will be supplied separately to make good any damage. Although not silent in use at the highest power, it is much less noisy than the Injector Furnace, and a lecturer with a good voice can be heard whilst it is working at full power.

POWER. When used as a blast furnace, as shown in Fig. 1, an empty crucible $2\frac{1}{2} \times 2\frac{1}{4}$ inches can be raised to the fusing point of cast iron in two minutes, starting all cold.

When the plug C (Fig. 1) is removed and replaced by the chimney, the blower being stopped, it will raise the crucible to bright redness in about ten minutes. This requires the gas to be turned very low, and the adjustment of the gas as a draught furnace requires some little practice to obtain the best results. If the gas is in excess it burns at the top of the chimney instead of in the furnace, and, of course, does no work. The best results are obtained when the gas is connected to the straight jet, but it



will work as a draught furnace fairly well if the gas is connected at the side jet in the same way as when used for blast, but, of course, with a much smaller supply of gas.

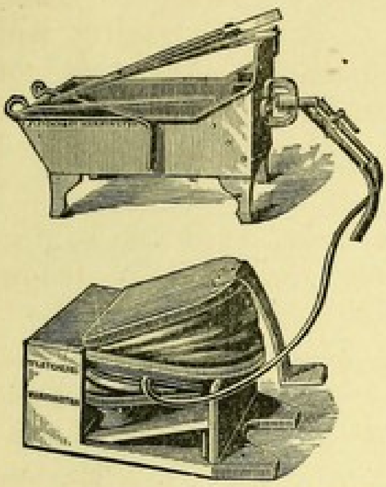
By turning the casing on its side, the contents may be seen by a class whilst the furnace is working, and it can in this position be used for crucibles, muffles, combustion tubes, cupels, or roasting; and with either draught or blast according to the temperature required.

The plug D is perforated for distillations by descension, and when removed will admit of a one-inch combustion tube being passed through the furnace. When used with blast the instructions for the Injector Furnace must be followed, the only difference being that the Lecture Furnace is more silent, and about twice as quick in working. The crucibles are Morgan's Patent No. O size, and larger sizes must not be used.

NOTE.—When used with a blast and the air is in excess, the burner is liable to scream. If it does so, it is a sign that the gas supply is deficient for the blast used. When the lid is lifted, close the revolving burner slide. The price does not include crucible tongs.

Extra Muffles, fireclay, 9d. Salamander, 1s. 6d.
„ Crucibles, „ 2d. „ 4d.

FLETCHER'S GAS OR PETROLEUM FORGE.



As Used at Woolwich Arsenal.

This simple arrangement is the only system by which steel tools can be forged without injury by the use of gas. It will be found a perfect arrangement for small odd forgings. It is perfectly clean, no nuisance either in lighting or use, and is always ready for instant use. Starting all cold, a slide rest tool can be repaired or shaped in two minutes.

Size of Hearth, 15 × 18 inches.

The Blower No. 5, 9c, is Fletcher's Foot Blower, dispensing with the use of the indiarubber disc, and fitting it for the roughest work.

It does not give so steady and powerful a blast as figure 9, or 9b, but it is adapted for forge or blowpipe use, and not being fastened to the forge, both blowpipe and blower can be taken away and used separately for brazing, &c.

The blower, Fig. 9b, No. 5, is the best, if used with reasonable care. Fig. 9 is liable to damage with sparks, &c.

INSTRUCTIONS.

Fill the hearth with coke, broken small (cinders may be used, but are not so clean); light the gas at the blowpipe, and use the blower. In a minute turn the gas out, and then turn on again a *very small quantity, not enough to burn at the blowpipe jet,* but sufficient to visibly brighten the fire. When the heat is obtained, the forge may be worked with or without gas, but a little gas doubles the power. THE GAS MUST NOT BURN AT THE BLOWPIPE JET EXCEPT FOR THE FIRST MINUTE. If gas is not available, the vapour from the smallest size Generator, page 23, may be used precisely in the same way as gas.

The Blowpipe is the ordinary pattern, Fig. 8c, and can be removed for use as a blowpipe, making the whole apparatus complete for all small heating and brazing work. If a hood is required, it will be made any shape desired, price about 6s. extra. It is not usually necessary if coke is used.

Price :—

Blower only, No. 5, 9c ...	£2	0	0	Hearth	£0	15	0
Do. 5, 9b ...	1	10	0	Tools, as shown in Engraving	0	5	0
Blowpipe	0	10	6	6ft. Indiarubber Tubing	0	4	0

This can now be supplied either as engraved or with the blowpipe arranged to give a top heat on the coke.

DRAUGHT CRUCIBLE FURNACES. Fig. 63.

FOR COAL GAS OR AIR GAS.

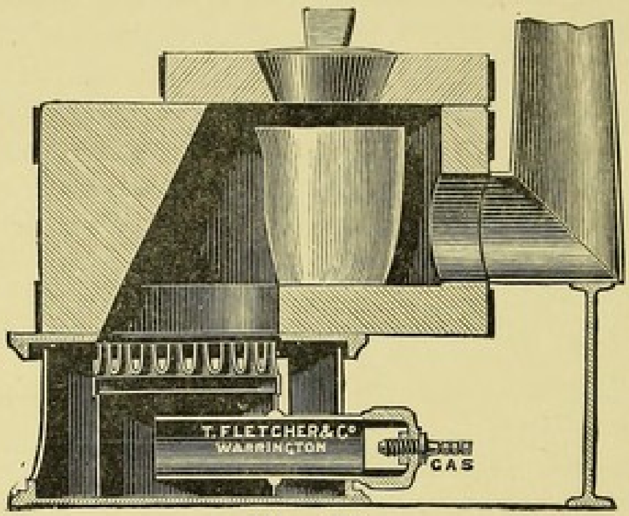


Fig. 63.

For Brass Casting, Jewellers' and general purposes. (Not for Cast Iron.)

No. 163, taking crucibles not exceeding 3 by 2⅝ in., to melt 2lb. brass.

Price complete, £1 10s.

Extra crucibles, Salamander 4d., clay 2d.; crucible tongs 1s. 6d. Gas supply required, 20 cubic feet per hour=½in. pipe and tap.

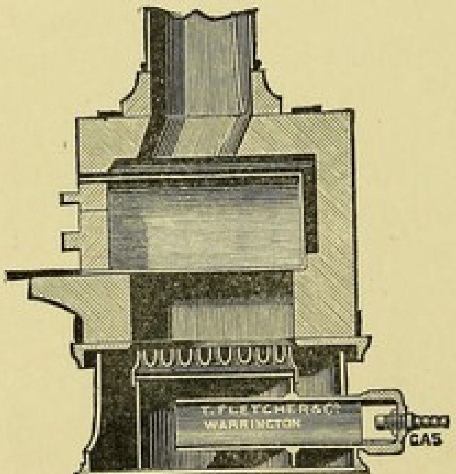
No. 363, taking crucibles not exceeding 4 by 3½in., to melt 6lbs. brass; gas supply, 25 cubic feet per hour=½in. clear bore gas pipe and tap. **Price complete, £2 5s.**

Crucible tongs, 2s. Extra Salamander Crucibles, 1s. each. Clay Crucibles, 5d. each. Bow Tongs, 3s.

This pattern, in both sizes, can be used for oxidising in cupels or shallow dishes, instead of a muffle furnace. The lid never requires to be lifted; it can be pushed sideways sufficiently to enable the crucible to be lifted out.

MUFFLE FURNACES,

FOR COAL GAS OR AIR GAS.



Muffle Furnace with Draught Burner, showing internal arrangement.
Fig. 61.

No. 261.—Space inside Muffle, 2½in. wide, 2in. high, 4½in. long. Price complete, 40s.

Extra Muffles, Salamander, 1s. 6d.; clay, 9d.

The burner for this size is same as No. 163.

The same arranged as a Blast Furnace for high temperatures. This requires about double the gas supply required for a draught burner. Price complete with injector burner, blower, **No. 3, Fig. 9b**, and tubing, 68s. 6d.

Gas supply pipe, ½in. bore.

For both draught and blast, **73s. 6d.** (both arrangements complete).

No 461.—Space inside Muffle, 3⅞in. wide, 3in. high, 6½in. long. Price complete, 50s.

THE SAME ARRANGED AS A BLAST FURNACE, as specified above, with blower No. Fig. 5, 9b, 83s.

For both draught and blast, £4 15s.

Extra Muffles, Salamander, 3s. 6d., clay, 1s. 9d. Gas supply required for the draught burner, 60 cubic feet per hour, ⅝in. gas pipe and tap.

No. 661.—Space inside Muffle, 5⅝in. wide, 4½in. high, 9in. long. **Price** complete, **£4.**

THE SAME ARRANGED AS A BLAST FURNACE, as specified, with blower **No. 5, Fig. 9b, £5 13s.**

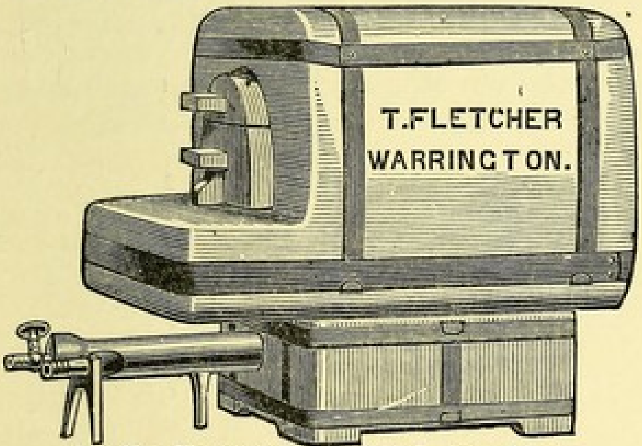
For both draught and blast, **£6 8s.** (both arrangements complete).

Extra Muffles, Salamander 6s., clay 3s.

No. 761, 6⅞in. × 5⅞ × 11½in., **£6.**

THE SAME ARRANGED AS A BLAST FURNACE, with blower **No. 5, Fig. 9b, £7 13s.**

For both draught and blast, **£8 8s.** Extra Muffles, clay 5s. 6d., Salamander 11s.



Muffle Furnace, arranged for Blast, external view.

Gas supply required for the draught burner, 70 cubic feet per hour, ⅝in. clear bore gas pipe and tap. All prices include one fire-clay muffle. Gas taps with large way through kept in stock.

NOTE.—The blast cannot be applied to these whilst working with draught, and with the blast arrangement the gas supply must be about double that specified for use with the draught burners. For instructions for blast arrangement, see Injector Furnace.

FROM THE JOURNAL OF THE SOCIETY OF CHEMICAL INDUSTRY, SEPTEMBER, 1889.

"The furnace used for cupellation is a muffle furnace, and, after having worked with many forms, we find that no furnaces are to be compared, both for accuracy in assaying and for ease and comfort in working, with Fletcher's gas furnaces. At Chester Assay Office a pair of these furnaces have been used for the last eight years, and have been found most satisfactory. The muffles are 9¾in. by 5¾in., and each muffle is capable of cupelling 32 gold assays at a batch (*i.e.*, of taking eight cupels, each cupel taking four assays). With gold assays they burn 75 cubic feet of gas per hour, but with silver assays, where only 20 assays are cupelled in a batch, and the temperature is much lower, they burn from 50 to 55 cubic feet per hour, and with the price of gas at Chester (3s. 4d. per 1,000) they cost 3d. per hour for cupelling gold, and about 2d. per hour for cupelling silver. The number of assays made last year at the Chester Assay Office, from articles sent to be hall-marked, was 25,100."

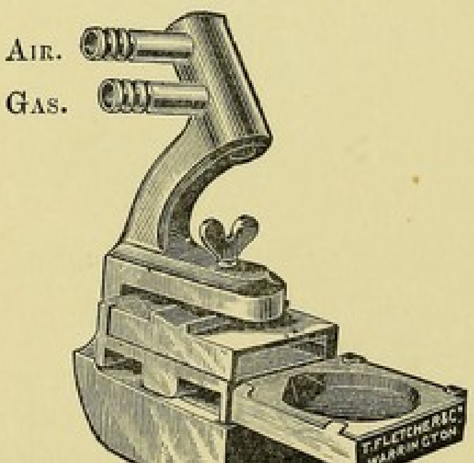
GENERAL INSTRUCTIONS FOR DRAUGHT FURNACES.

The gas supply tap and pipe must be large and clear, so as to give as great a pressure of gas as possible at the burner nozzle, although the actual consumption of gas is small. The indiarubber tubing used must of necessity be perfectly smooth inside. The tubing made on wire, whether the wire is removed or not, *will not work these burners satisfactorily*. All Crucible and Muffle Furnaces are sent out with a 2ft. 6in. chimney, having a cast-iron foot to enable it to stand steadily, and a short handle by which it can be readily lifted with the crucible tongs. The gas supply specified is required to work each Furnace at its full power, and the flame must be visible in the chimney. If the gas supply is deficient, the Furnaces can be worked at a lower heat by partially closing the top of the chimney until the flame becomes visible, or by working without the chimney. If the burner plate becomes red hot, it is a sign that the gas supply is deficient. The points of blue flame are always visible when the burner is looked into sideways, unless the gas supply is too small to work the Furnace satisfactorily. To light the burner without removing the upper part of the furnace, put a lighted taper through the burner casing up between the grooves in burner plate, then turn the gas on slowly. If the Furnace is hot it may be necessary to cover the air opening round the gas entrance to prevent the flame descending through the gauze at the moment of lighting. The burners can be easily taken apart, and must be kept clean.

Extra Grids for Burners, 2s. each.

FLETCHER'S NEW MELTING ARRANGEMENT.

ADDITIONAL PATTERNS.



For melting gold or silver rapidly, without the use of a furnace. In this arrangement the two parts of the ingot mould slide on each other, to enable ingots of any width to be cast, and the Blowpipe is part of the rocking stand. Connect the blower to the upper tube and the gas to the lower. When the metal is melted in the shallow crucible tilt the whole apparatus over so as to fill the ingot mould. A sound 3-oz. ingot can be obtained in about two minutes, and a 20-oz. in five minutes. Thousands of these are in use, and this arrangement is far superior to any furnace for small work.

Very bulky scrap should be run into a mass in one of the moulded carbon blocks before being placed in the crucible.

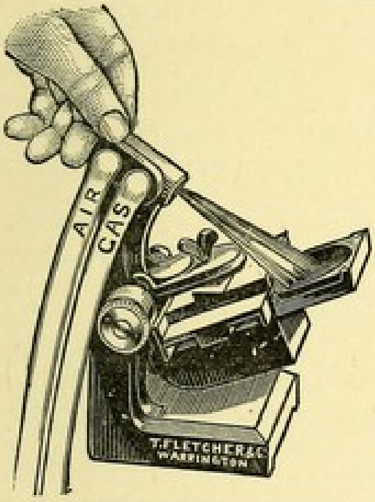
Price, as engraved, 3-oz. size, **13s. 6d.**

Extra Crucibles, 4d. each: 3s. 6d. per doz. Slides to carry the Crucibles 2d. each.

LARGE SIZE OF THE ABOVE.

To melt 14 ounces silver, or 20 ounces 18-carat gold, in 5 or 6 minutes.

Price, 27/6. Extra Crucibles **7d.** This requires a ½-inch gas supply and Foot Blower No. 5 size.

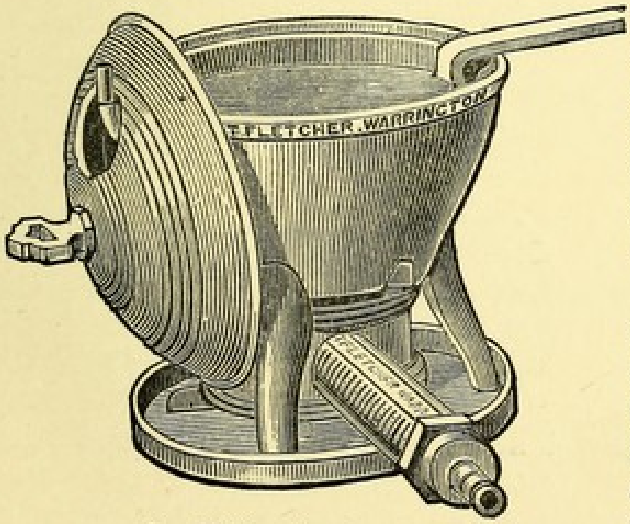


The same arrangement as the above, on heavy swivel stand, to prevent risk of pulling over by the weight of the rubber tube when not held by the hand. Small size only, for 3-ounce ingots. **Price 15s. 6d.** This addition is unnecessary in the large size.

Extra Crucibles 4d. each, 3s. 6d. per dozen.

FLETCHER'S NEW LADLE FURNACES.

FOR LADLES, AND SET POTS.



Small Size, for 7in. Ladles.

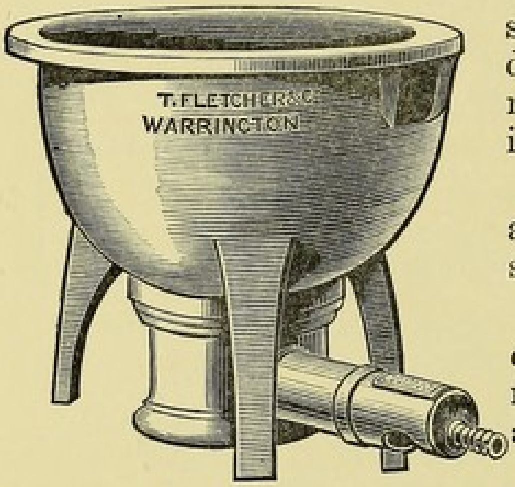
A new and substantial form is now made in three sizes. The two smaller sizes take the No. 4 High Power Burner, the largest requires the 6in. High Power Burner.

The smaller size, taking ladles 7in. in diameter, is made for ladles only. The burner will heat soldering irons, or boil water quickly, and is useful in many ways. **Price** complete **13s.** without ladles, but including a metal skimmer and hook for lifting the lid. The body and lid are arranged to admit the handles of different size ladles at different heights, to enable them to be kept perfectly level.

No. 2 Size Furnace is made to take ladles $8\frac{1}{4}$ inches wide, $4\frac{1}{2}$ inches deep, outside measure. **Price**, complete with ladle bowl without handle, **20s.** Special handles to order.

No. 2 Size, B Pattern.—The same furnace with side flue and set pot for stereotypers, &c., to use with a small dipping ladle, and safe against splashes of metal on the burner. These can also be used as lead baths for tempering tools and similar work. **Price**, complete with set pot, as engraved below, and with a lid which fits the furnace, with or without the set pot, **22s. 6d.**

No. 3 FURNACE FOR SET POT.



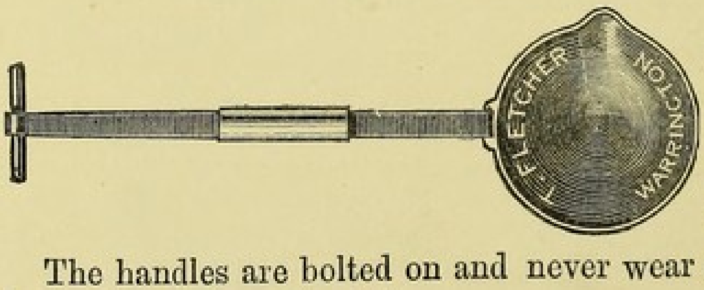
No. 3 Size Furnace, taking set pot 12 inches wide, $7\frac{1}{2}$ inches deep, to hold 1 cwt. solder or stereo metal, which can be readily melted in 1 hour, starting all cold.

Price complete with set pot and burner, **28/6.** No lid or stand is supplied with this size.

No. 3 size requires a $\frac{3}{4}$-inch clear bore pipe and tap, and is not made to take ladles which require a support over the burner.

It is desirable that this size furnace should stand under a hood to remove the burnt gas from the room, unless it is well ventilated.

FLETCHER'S NEW ZINC AND LEAD LADLE.



These ladles are made with both cast iron (for lead) and malleable (for zinc) bowls—true to shape and thickness.

The handles are bolted on and never wear out. A new bowl can be fixed in a few minutes.

The handles ensure perfect steadiness in pouring, and are ALWAYS COLD; the sliding handle being pushed to the cool end whilst the metal is being heated.

The bowl is 7 inches in diameter, and fits both old and new pattern small size ladle furnace.

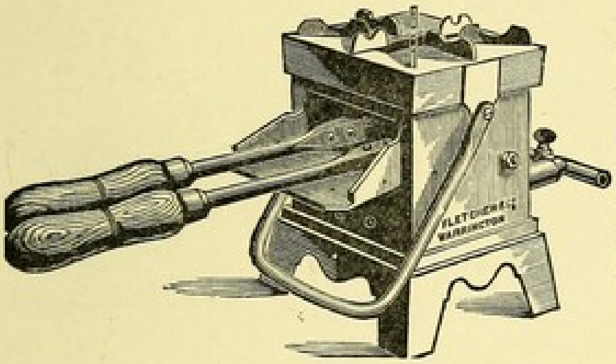
Price, *with cast-iron Bowl*, **4s.**; *with malleable Bowl*, **6s. 6d.** *Extra Bowls: cast*, **1s. 3d.**; *malleable*, **3s. 9d.**

FLETCHER'S TINMAN'S FIRE POT.

This is a new and substantial pattern, specially designed for workshops where coke stoves cannot be used.

Each stove will heat rapidly either one or two large copper bits, and the waste heat after leaving the copper bits can be used for boiling breakfast cans, &c.

The top can be opened by a hinge and the stove used for heating ladles, making solder, or tinning.



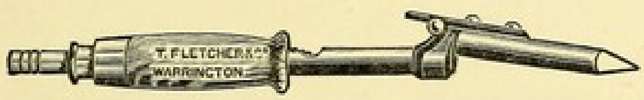
The swing handle enables the stove to be carried about by case makers, &c., and the apparatus will be found a thoroughly good and practical workshop tool for permanent hard use.

Price 16s.

Lead Pot, with spout and swing handle, to hold and melt 20lbs. lead or solder, **3s. 3d.** extra.

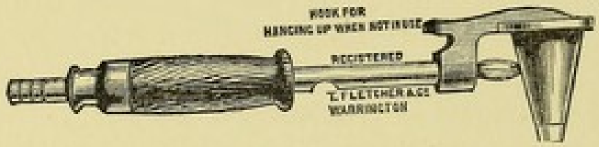
FLETCHER'S REGISTERED SELF-HEATING SOLDERING BIT.

This is free from smell, heats rapidly, and will be found a first-class arrangement for case makers, stained glass leading, sardine box making, and similar work. It is not suited for the heaviest class of coppersmith's work.



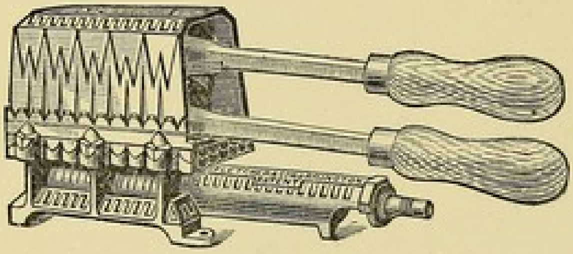
The copper can be renewed in a minute when worn down. The gas supply from an ordinary bracket, with the gas burner removed, will be found ample. **Price 6s.**

FLETCHER'S REGISTERED SELF-HEATING SOLDERING BOLT FOR LEADED WINDOW MAKERS.



This will be found a first-rate tool for the special class of work for which it is designed, requiring very little gas, and being fully equal to the requirements of the quickest workman. It is cool to the hand, and perfectly clean in use.

Price 6s. 6d.



12 S. Price 5s. The same as 10 S, with cover for soldering bolts. This will heat two heavy bolts at once with one burner.

The same burners in sets of 2 or 3, on cast-iron stand, with tap to each burner, **8s. 3d.** per burner.

PLASTIC FIREBRICK.

FOR ALTERING AND LINING FAULTY FIREPLACES WITHOUT REBUILDING, AND REPAIRING LABORATORY FURNACES.

Can be made by mixing liquid Silicate of Soda with ordinary Fireclay to the required consistency.

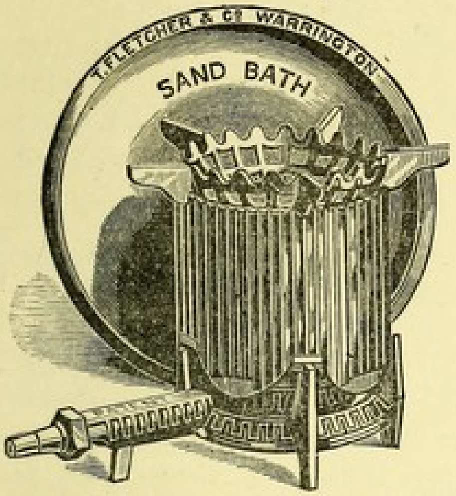
Silicate of Soda, in any quantity, 3d. per lb. Packages of any quantity under 28lbs., 1s extra. In 5 cwt. casks, at a lower rate.

The mixture ready prepared for immediate use, 14lb. tin, 5s.; 28lb. tin, 8s. This will not keep soft more than a few days.

This sets hard without requiring to be burnt in a kiln. If a thick body is required for filling up or altering fireplaces, the space should be filled with broken bricks, and the Plastic Firebrick used only to cement and fill up the crevices, so as to form a good smooth face.

NEW LABORATORY BURNERS.

There are probably few chemical or physical laboratories in the world where the well-known low temperature burners are not in constant use. The New Laboratory Burners serve a similar purpose, but with a much wider range, and without any liability to damage with the roughest use.



The stand for vessels will carry round glass flasks, porcelain dishes, or flat-bottomed vessels of any size with perfect steadiness.

The vessels can, by lifting the cylinder, be placed at different heights above the flame, which will burn steadily when turned down to its lowest point.

A SAND BATH can be supplied with each.

These Burners will be made in four sizes.

No. 10.—Price, 6/6. Sand Bath, 1/3 extra. Height adjustable from 6½ to 7½in.

Support for flasks, 4¼in. diameter, 1¼in. deep, and for flat vessels, 6½in. diameter.

Sand Bath, 9in. diameter, 1in. deep.

Gas consumption per hour, maximum 10 feet, minimum 1½ feet.

No. 15.—Price, 8/-. Sand Bath, 1/9 extra. Height adjustable from 7 to 8in.

Support for flasks, 5¼in. diameter, 1½in. deep, and for flat vessels, 7½in. diameter.

Sand Bath 10in. diameter, 1in. deep.

Gas consumption per hour, maximum 15 feet, minimum 2 feet.

No 20.—Price 11/-. Sand Bath, 2/6 extra. Height adjustable from 8 to 9in.

Support for flasks, 7in. diameter, 1¾in. deep, and for flat vessels, 9in. diameter.

Sand Bath, 13in. diameter, 1in. deep.

Gas consumption per hour, maximum 20 feet, minimum 3 feet.

No. 30.—Price, **19/-**. Sand Bath, **3/-** extra. Height adjustable from $9\frac{1}{4}$ to $10\frac{1}{2}$in.

Support for flasks, 8in. diameter, 2in. deep, and for flat vessels, 11in. diameter.

Sand Bath 15in. diameter, 1in. deep.

Gas consumption per hour, maximum 30 feet, minimum $1\frac{1}{2}$ feet.

This size has two concentric burners, with separate taps to each.

The burners are our stock patterns of Standard Burners, and can be used separately for quick boiling.

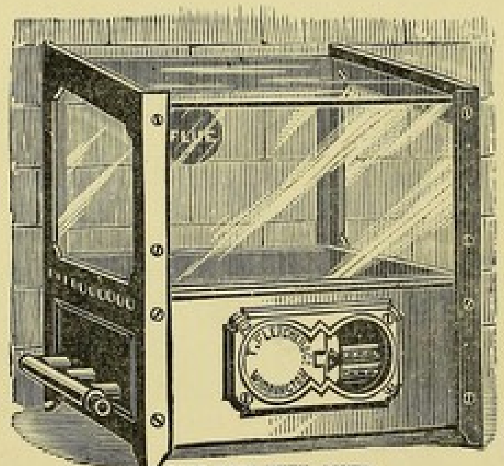
GOVERNORS.—It is not generally known that a good governor (such as those made by Hearson and Co., Regent Street, London) placed on the whole gas supply of the laboratory makes it possible that exact work may be carried out, and that very close temperatures may be obtained for long periods without any attention whatever.

The use of a good governor along with these burners will be found to simplify many operations in the laboratory, which, under ordinary circumstances, are almost impossible without very complicated apparatus and constant skilled attention.

SAND BATH FOR LABORATORY USE.

WITH COVER, FOR EVAPORATING CORROSIVE LIQUIDS.

Size of bath, clear inside, 12 inches square.



SAND BATH WITH COVER

Price with tap to each burner, so that the temperature may be controlled in any part, **45s.** The back is open, to fit against a wall with a flue.

SUNDRIES.

JEWELLERS' SOLDERING COALS.—Made of compressed willow charcoal (same as moulded carbon blocks). **Size 2 × 2 × 6 in.,** with flat sides, **Price 1s.** One of these will last out 50 blocks of charcoal. **Size $1\frac{1}{2} \times 1\frac{1}{2} \times 5$. Price 6d.**

MOULDED CARBON BLOCKS for supporting small work under the blowpipe, Cleanly, perfect non-conductors, and everlasting. **Price 1s. 6d. each.** (For use with small blowpipes only.)

These are circular, hollow on each face, and 4 inches diameter.

FINE WILLOW CHARCOAL, in sticks free from flaws (selected sticks only), 1s. per lb.

CHARCOAL for Blowpipe Analysis with Brown Ash can occasionally be supplied. Price 2s. per lb.

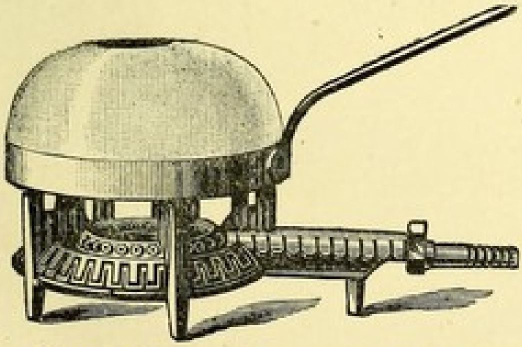
IN ORDERING if the exact apparatus required cannot be specified, the work to be done should be precisely and minutely explained. Size of blowpipe jets should be stated.

ALL INDIARUBBER TUBING used must be **SMOOTH INSIDE,** made without wire, and of as large a bore as can conveniently be used.

RUBBER TUBING $\frac{5}{16}$-inch, $4\frac{1}{2}$d.; $\frac{3}{8}$-inch, 6d.; $\frac{1}{2}$-inch 9d. per foot.

IF THIS LIST IS THREE MONTHS OLD please apply for a fresh one before ordering, as constant improvements are being made, and new apparatus being designed.

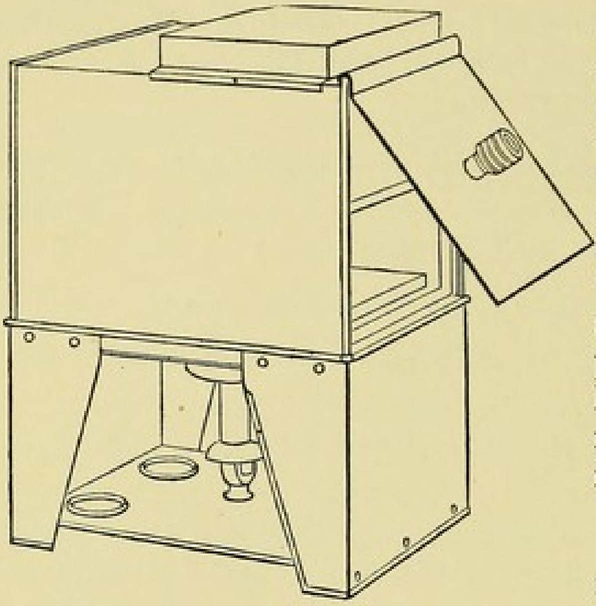
PLATE DRYER AND HEATER FOR DENTISTS' USE.



This consists of a porous fireclay dome, resting on one of our No. 10 standard burners; size of dome inside, 4in. diameter, 2in. deep. It will take work up to 3 inches diameter, and will heat a block of iron over 1lb. weight to clear redness with the ordinary burner as engraved, without the assistance of a blowpipe or blast of air.

		s.	d.
Price, Burner	... ...	1	10
,, Dome	... ...	4	0
,, Complete	... ...	5	10

DRYING OVEN WITH WATER JACKET.



Specially designed for Dentists' use, size 6in. wide, 5in. high, 8in. deep, clear inside measure. This is made of heavy copper throughout, riveted and seamed, and designed for heavy continuous work. Hanging door, two sliding shelves of copper, plate over the water filling hole, of tinned copper, hammered and polished, for warming rubber for packing.

Price, complete, with burner and copper stand, **42/6**.

Smaller sizes to order at the same price, larger sizes at a small additional cost. These are made in the most substantial manner possible. Cheap or lightly made water jacketed ovens are worse than useless for permanent service, being constantly out of order.

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