A THOUSAND AND ONE FORMULAS

The Laboratory Handbook for the Experimenter

With an Appendix of Useful Tables

BY

SIDNEY GERNSBACK

FULLY ILLUSTRATED

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EXPERIMENTER'S APHORISMS

In the following, we wish to give to the experimenter some hints as to the use of the different ingredients and how to work them:

(1) Always bear in mind that exact working of a formula requires ACCURACY, CLEANLINESS, PATIENCE, and SKILL.

(2) Know what you are about, before you start to experiment.

(3) "THE HISTORY OF FAILURES IS THE HISTORY OF SUCCESS" goes an old adage, and it applies well to the experimenter.

(4) Many times impure, wrong or deteriorated raw materials, spell FAILURE instead of SUCCESS.

(5) A great many of the chemicals and ingredients required, cannot be obtained from drug stores; buy them at a reputable supply house.

(6) BEFORE CONDEMNING A FORMULA, be sure the fault does not lie with the manner of handling it, or the purity of the ingredients.

(7) Be sure to mix the materials comprising a certain formula in the proper sequence.

(8) When starting to prepare a mixture, especially one containing liquids, ask yourself: "IS THE SPECIFIC GRAVITY CORRECT, AS INDICATED BY A HYDROMETER? IS THE TEMPERATURE RIGHT? IS THE QUANTITY OR WEIGHT RIGHT?"

(9) Acids and water, when mixed, should be manipulated in the proper manner, i. e., THE ACID SHOULD BE POURED INTO THE WATER, and not vice versa, as the solution is liable to be forcibly ejected from the containing vessel and into the mixer's face.

(10) For any kind of SYSTEMATIC WORK, a floating THERMOMETER and HYDROMETER, as well as measuring glasses and scales, should always be provided, as GUESS-WORK is EXPENSIVE and SOMETIMES FATAL.

(11) Put labels on ALL bottles, boxes and packages with FULL INSCRIPTION as to their contents, it will avoid troubles and mistakes.

(12) Remember that a beginner cannot expect to make articles AT FIRST, which will compare with regular manufactured products. S.G.

Cements and Glues.

CEMENTS FOR WORK SHOP.

Leather Belting Cement.—Take 1 part of *Common Glue;* 1 part of *American Isinglass.* Place them in a boiler and add water sufficient to just cover the whole. Let it soak 10 hours, then bring to boiling and add pure *Tannin* until the whole becomes ropy or appears like the white of egg. Apply it warm. Buff the grain off the leather where it is to be cemented, rub the joint surfaces together; let it dry for a few hours, and it is ready for use. It will not need riveting, as the cement is nearly of the same nature as the leather itself.

Cementing Brass to Glass.—16 parts of *Copal Varnish;* 5 parts *Drying Oil;* 3 parts *Turpentine;* 3 parts *Oil of Turpentine;* 5 parts *Liquid Glue;* 10 parts *Stucco.*

Cement for Glass and Porcelain.—1 part of *Casein;* 6 parts of *Sodium Silicate.* Dissolve; apply at once and dry in the air.

Chemical Cement.—Mix together 5 lb. of *Resin;* 1 lb. of *Wax;* 1 lb. of *Red Ocher;* 2 oz. of *Plaster of Paris.* Melt the whole with moderate heat.

Cutler's Cement.—4 parts of *Resin;* 1 part of *Beeswax;* 1 part of *Plaster of Paris.*

Electrical Cement.—5 oz. of *Resin;* 1 oz. of *Beeswax;* 1 oz. of *Red Ocher.* Dry the ocher on a stove. Melt the wax and resin together and stir in the powder till cold. Best cement to fasten brass on glass tubes, etc.

Iron Cement.—7 lb. of *Iron Borings;* 2 oz. of *Sal Ammoniac;* 1 oz. of *Sulphur; Water* in sufficient quantity.

Stone Cement.—25 parts of *Linseed Oil;* boil with 35 parts of *Litharge* and 250 parts of fine powdered *Burned Lime.* Use hot.

Waterproof Cement.—1 part of *Glue;* 1 part *Black Rosin;* ¼ part *Red Ocher.* Mixed with least possible quantity of *Water.*

Cement for Wood.—Melt in an iron pan 1 oz. of *Resin;* 1 oz. of pure *Yellow Wax,* and stir in 1 oz. of Venetian Red. Use while hot. When cold it is as hard as stone.

LIQUID GLUE.

Chloral Hydrat, 250 grams, Gelatin, 400 grams; Water, 1,000 grams. The solution is ready in 48 hours.

HARD CEMENT.

A hard cement is made from plaster of paris, 6 parts; 2 parts silex or fine sand and 2 parts dextrine. Mix with water until soft, then work with a knife.

CEMENT FORMULA.

Powdered Casein—4 ozs.
Powdered Slaked Lime—5 ozs.
Powdered Barytes—20 ozs.
Mix thoroughly.

In use pour a little of the powder into any convenient vessel, and sufficient water to form a stiff paste, and work or stir with a small stick until thoroughly mixed.

Let this mixture stand for 20 minutes before using. *This is important.* The article to be mended should be free from all dirt and grease before applying the cement, and should be perfectly dry.

For Mending Holes in Pots, Pans, etc.:—Fill the hole with the paste, applying to both inside and outside surfaces, allow it to dry for four hours, then fill the vessel with water, place on the fire and let boil, pour out the water, wipe dry and let stand in the air for two to six hours longer. If desired, after the cement is thoroughly hardened, the place may be smoothed up with sand paper. For extremely large holes place the vessel to be mended on a piece of paper, and fill hole with the paste from the inside. Let the paper remain until the cement is thoroughly hardened, then burn off. *Do not tear off.*

For Mending Marble, Glass and Bric-a-brac:—Apply the paste to both broken surfaces in a thin layer, press closely together and allow to harden in the air for six to twelve hours.

Do not omit letting the mixture stand for twenty minutes after mixing with water. This is essential for the casein to become thoroughly dissolved and amalgamated with the remaining ingredients.

GLUE RECIPES.

Glue to Resist Moisture—One pound good flake glue, melted in two quarts of skimmed milk.

Glue-Cement to Resist Moisture—Four parts good glue, 4 parts black resin, 1 part red ochre; mix with least possible quantity of water.

Marine Glue—One part of India rubber, 42 parts of mineral naphtha or ocal tar;heat gently, mix and add 20 parts of powdered shellac; pour out on a slab to cool. When used, it should be heated to about 250° Fahr.

BAKED SHELLAC FOR CEMENTING GLASS TO GLASS, GLASS TO METAL AND CHINA.

In my work as a laboratory assistant I have tried many cements, but have found that none work as well as ordinary *baked shellac* used as follows:

Use an ordinary shellac and alcohol mixture, boil it down over a flame until the shellac becomes fairly thick, warm the articles to be mended a little and apply the shellac to the parts. Apply pressure to the parts by tying with wires or weighting them. Put the whole in an oven of constant temperature and bake for about twelve to twenty-four hours. The temperature of the oven is very important; it should not exceed 200°F. and by no means 212°F. Too much heat only chars the shellac and makes it bubble up.

This method of cementing is so effective that pieces will break at other places rather than at the point. The shellac, once baked well, as directed, is proof to most all acids; H_2SO_4, HCl, HNO_3, and chromic acid do not seem to affect it in any way. It is also waterproof. In fact I can find nothing so far that will dissolve or soften it. I have used an electric sterilizing oven when baking the shellac.

Another good cement, sometimes called aquarium cement, is a mixture of litharge and glycerine, made into a paste and allowed to set for two days after applying.

CEMENT FOR ATTACHING GLASS TO METAL.

Take about 2 ounces of a thick solution of glue and mix with it 1 ounce of linseed oil varnish and ½ ounce of pure turpentine. This mixture is next boiled in a covered crock and is then ready for use. The articles after being cemented should be clamped together for several days to allow the cement to set properly.

FORMULA FOR GUM THAT U. S. USES.

Dissolve 2 ounces of dextrin in 5 ounces of water and 1 ounce of acetic acid and 1 ounce of Spirit of Wine.

CEMENTING BRASS TO PORCELAIN.

Use thoroly dry litharge and pure glycerine. To avoid trouble see that no water is in the glycerine or the litharge damp. If the litharge or glycerine contains water it should be carefully dried at a low temperature and the glycerine heated over a slow flame until the water is driven off. The litharge and glycerine should then be thoroughly mixed, using as little glycerine as possible. After this preparation has been applied it requires five to seven hours to dry.

SILICA FILLING CEMENT.

Pour one gill of *Silicate of Soda* or *Potash* in a large tumbler (the *Silicate of Soda* or *Potash* is commercially known as *Soluble Glass* and can be bought at any wholesale druggist).

Now add one gill of *Water* to the *Soluble Glass* and mix the two liquids with a wooden stick. In another glass tumbler pour another gill of *Water,* to which is added one gill of *Hydrochloric Acid* (called also *Muriatic Acid*).

Now slowly pour the *Muriatic Acid* and *Water* into the tumbler containing the soluble glass solution and a gelatinous silica will be thrown to the bottom of the glass, pour off the excess liquid left in the glass. Wash the gelatinous silica in a little water, allow to dry. When dry the silica will be in the form of powder. This powder is pure silica.

Mix the pure silica with soluble glass to which no water has been added, until it forms a creamy paste. Apply quickly. This forms a very hard cement, suitable for repairing and filling in holes, cracks, seams in marble, stone, and wood, also glass and almost any place where a hard stone-like cement is needed.

AN ACID-PROOF CEMENT.

A cement which is proof against boiling acids may be made from India rubber, tallow, lime and red lead.

The India rubber must be first melted by a gentle heat and then 6 to 8 per cent by weight of tallow is added to the rubber while it is kept well stirred; next dry slaked lime is applied until the fluid mass assumes a consistency similar to that of soft paste; lastly, 20 per cent of red lead is added in order to make it harden and dry.

CEMENT FOR CELLULOID.

Small celluloid articles can be repaired with this simple cement. Dissolve one part of camphor in forty parts of alcohol and add an equal quantity of shellac. The cement is applied hot to the parts to be mended and the parts are held together until cooled.

WATERPROOF CEMENT FOR CELLULOID.

Celluloid is becoming increasingly popular as a material for making a great many articles. Broken parts are sometimes cemented with a form of glue, made by melting gelatine in sufficient glacial acetic acid to cover it by means of gentle heat, after first standing for 24 hours in the cold. This cement, while strong, is not waterproof. A better cement, and one that will withstand the action of water, can be made by dissolving small cuttings of celluloid in acetone to the consistency of a thick syrup. After applying this solution to the parts that are to be united the work must be placed under pressure and left for some time until the cement is quite hard.

Compositions of all kinds.

COMPOSITION OF ALL KINDS.

1. *Flexible Insulating Mass.*—Forty parts of *Shellac;* 40 parts of dry, finely pulverized *Asbestos, Flax Cotton, Wood* or *Paper;* 25 parts of *Wood Tar;* 1¼ part of *Paraffine.* Mix together in a vessel at 100 to 200 degs. F.

2. *Gutta Percha Composition.*—Six parts of *Gutta Percha;* 2 parts of *Bone Dust;* 1 part of *Pipe Clay.*

3. *Insulating Compound.*—One part of Stockholm *Tar;* 1 part *Resin;* 3 parts of *Gutta Percha.*

4. *Composition for Mouldings, Frames, Etc.*—Twelve parts of *Whiting;* 6 parts of fine sifted *Sawdust;* 1½ parts of *Linseed Oil Cake.* Knead this mass to a paste with a strong solution of glue.

5. *Another.*—Eight parts of *Pulverized Litharge;* 16 parts of *White Lead;* 2 parts of fine *Sawdust;* 20 parts of *Plaster of Paris.* Stir these ingredients into 26 parts of glue dissolved in sufficient water.

RECIPES FOR JEWELERS' ENAMELS.

Melt together the combinations of materials as given below to make the various colors of enamel. Portions by weight.

Transparent Red.—Cassius gold purple, 65 parts; crystal glass, 30 parts; borax, 4 parts.

Transparent Blue—Crystal glass, 34 parts; borax, 6 parts; cobalt oxide, 4 parts.

Dark Blue—Crystal glass, 30 parts; borax, 6 parts; cobalt oxide, 4 parts; bone black, 4 parts; arsenic acid, 2 parts.

Transparent Green—Crystal glass, 80 parts; cupric oxide, 4 parts; borax, 4 parts.

Dark Green—Crystal glass, 30 parts; borax, 8 parts; cupric oxide, 4 parts; bone black, 4 parts; arsenic acid, 2 parts.

Black—Crystal glass, 30 parts; borax, 8 parts; cupric oxide, 4 parts; ferric oxide, 3 parts; cobalt oxide, 4 parts, manganic oxide, 4 parts.

White, 1—Crystal glass, 30 parts; stannic oxide, 6 parts; borax, 6 parts; arsenic acid, 2 parts.

White, 2—Crystal glass, 30 parts; sodium antimonate, 10 parts. The glass used for this one must be free from lead.

A SUBSTITUTE FOR WAX COMPOUND.

When wax compound has gone up from 20 to 40 cents a pound it is not easy for the "lean-pocketbook experimenter" to encase large high frequency coils in the same. Below is a thoroughly tried out system which is guaranteed to work well.

Thoroly shellac the coil three times with orange shellac. Let each coat dry well, and when the last one is ready rub well with linseed oil, place in a snug box and pour a mixture of plaster of paris and water (thick) into the box, so that it is thoroly encased. When hard it may be left in a box or taken out and polished with oils and varnishes. This idea, if followed out correctly, makes a neat and compact and truly *invulnerable* coil.

STENCILS FOR CHEMISTRY STUDENTS.

All students of chemistry, whether they attend a residential school or not, have undoubtedly often wished for some form of transparent stencil with which they could artistically, yet rapidly draw diagrams; and especially sectional diagrams of the various flasks, test tubes and retorts used in such work.

Such stencils have recently been brought out by an English scientific house, and they are described herewith. This excellent set of stencils, which have been approved and permitted to be used by students taking chemistry in English schools and colleges, have been officially approved by the faculty of the University of London and also by the Indian Education authorities.

Undoubtedly, instructors in chemistry in high-schools and colleges will be pleased to have their students obtain such stencils, as the examination papers will then lend themselves to a much quicker perusal by the teachers. Moreover, they help the student to keep first-class notes in his data book and not a mixture of harum-scarum sketches, which are often so poorly executed that they are absolutely unintelligible when referred to at some future date.

HEKTOGRAPHS.

What are they, do you ask? The Century Dictionary defines it as follows: "A copying process in which the writing or drawing to be copied is made on smooth paper in aniline ink, and is then pressed upon a slab coated with gelatin, to which a part of the ink is thus transferred, and from which a number of duplicate impressions can be made; also, the special appliances, collectively, by means of which this is done." The chance, however, is that you do not want any definition, but might like some directions for simplifying the process, which some teachers and students who want a number of copies of text or drawing, are using successfully. Agreeable to this contingency, we have:

Receipt No. 1.—Soak an ounce of fish glue in cold water. Drain off the water; put the softened glue into a double boiler and melt it, but *do not* bring it to a boil. Obtain six ounces of glycerin, warm it and add it to the melted glue. Add a few drops of carbolic acid. Mix thoroly and pour into your pan. A caramel pan is best.

Receipt No. 2.—Add 3 ounces of water to 1½ ounces of white glue. Heat in a double boiler until glue is melted. Then add six ounces of glycerin and pour into pan. If too hard, add glycerin. If too soft, add glue.

Receipt No. 3.—Dissolve 4 ounces of gelatin in one pint of cold water; then add one pint of glycerin. Pour into a double boiler, and when it comes to a boil pour into your pan.

If bubbles appear on the surface, gently draw an edge of a sheet of writing paper over the surface before it cools. This will remove them.

General directions for use.—Use nothing but unglazed paper, which can be purchased at any store where typewriter paper is sold. In ordering, be sure to state that you wish to use it for hektography.

Use *hektograph ink* and a coarse stub pen. See that every stroke of the pen leaves a metallic luster when dry, else the work will not *take*.

When the ink is dry, lay the face of the sheet which you have written or drawn, down on the hektograph; press gently over the whole surface with the hand or soft cloth. After from two to five minutes (according to how many copies are desired) gently peel the paper off.

From the impression thus made, reproduce all the copies desired, laying one sheet on the hektograph at a time.

Hektograph ink all prepared may be bought, or your druggist will put it up for you. The following is the receipt:

Ink—Dissolve one dram of purple aniline in one ounce of water.

The hektograph solves the supplementary reading question. Each teacher, or any one who desires a number of copies of any text or drawing, can thus prepare as many as needed, at a very small cost.

ANOTHER FORMULA FOR MAKING A HECTOGRAPH.

As the price of a good printing set is usually beyond the means of the average experimenter, the following device will not be found amiss as an excellent substitute:

First obtain a shallow tin dish (the cover of a bread box will answer the purpose well), an ounce bottle, an ounce of gelatine, 1 ounce of brown Demerara sugar, 6 ounces of glycerine and 2½ ounces of barium sulphate. Break the gelatine into small pieces and place in a sauce-pan with 3 ounces of water and let this steep overnight. Next pour in the glycerine and heat over a fire. Put in the sugar and let it heat until dissolved. Then take the barium sulphate and mix with 1 ounce of water in a separate cup. Pour this into the sauce-pan, and when thoroughly mixed pour it into the flat tin dish (which should be well cleaned) and then allow the mass to harden.

Buy some hectograph ink, or make it at home by filling an ounce bottle with 2 drachms of methyl-violet aniline and 2 drachms of spirit and dissolve it in 1 ounce of water. Write on a piece of paper whateer you want to reproduce, and place the paper, face downward, on the rubber-like surface, rubbing same gently on the written matter. After one-half to one minute, pull the paper off. Then take another paper and press upon the hectograph, and it will be reproduced as many times as you repeat this operation.

To clean the hectograph wash it first with water, mixed with an eighth part of hydrochloric acid, also known as spirit of salt; then clean the surface with pure water. Let it stand for 12 hours before using again.

STILL ANOTHER HEKTOGRAPH.

Gelatin, 1 part; Glycerin, 4 parts; Water, 2 parts.

No. 1.—Ink for same: Methyl Violet, 1 part; Water, 7 parts; Alcohol, 1 part.

No. 2.—Rosaline, 2 parts; Water, 10 parts; Alcohol, 1 part.

SEALING WAX.

(Red). Take 4 pounds shellac, 1½ pounds turpentine, 3 pounds finest cinnabar and add 4 ounces Venetian red. Mix the whole well together and melt over a very slow fire. Pour it on a thick smooth sheet of glass or any other flat surface and make it into sticks.

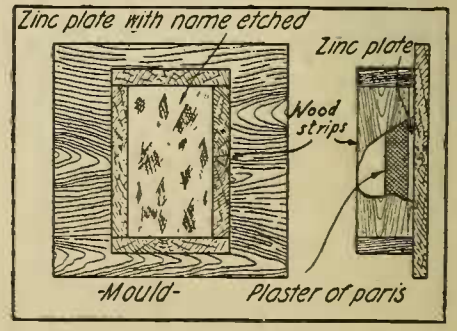
(Black). Take the best black resin, 3 pounds; beeswax, ½ a pound and finely powdered ivory black, 1 pound. Melt the whole together over a slow fire and mould into sticks.

WATERPROOF COMPOUND.

Suet, 8 ounces; linseed oil, 8 ounces; neatsfoot oil, 1½ ounces; lampblack, 1 ounce; litharge ½ ounce. Melt together and stir till cold.

A FACSIMILE RUBBER STAMP.

The following is a simple method whereby amateurs can make their own rubber



Mould for making Facsimile Rubber Stamp.

stamps. Place a piece of carbon copying paper face up upon a smooth table. On top of this place a piece of paper and write the desired name on same. The design will then be found traced upon the back of the paper and will read backwards.

Then place the carbon paper face down upon a smooth piece of zinc and the writing paper also face down on the carbon paper.

Now go over the reversed name on the back of the paper, thereby tracing the same design upon the zinc. After this go over the lines on the zinc with an acid-proof ink, made by mixing equal parts of pyrogallic acid and sulphate of iron. When dry apply hydrochloric acid to the face of the zinc, and after it has eaten deep enough wash off in running water.

A plaster cast is then made by pouring plaster of paris, mixed with water, upon the zinc, which is laid face up in a mould similar to that shown in illustration. When hard remove the cast and the impression will be found in same.

For those who are not experienced at vulcanizing rubber, or who do not care to go to the trouble, they can employ the following method:

India rubber, cut up in small pieces, is dissolved in highly rectified spirits of turpentine until semi-fluid. This mixture is then poured into the plaster cast, which has been previously dusted with powdered graphite. When hard it is removed and mounted.

The zinc can also be mounted type-high on a block of wood and used in a printing press.

ARTIFICIAL AMBER.

Dissolve shellac in an alkaline lye; then mix with a solution of chlorin until the shellac is entirely precipitated. Wash in water and heat gently till it runs clear. It can then be molded.

ARTIFICIAL IVORY.

Four parts sulphuric acid, 50 parts water. Macerate peeled potatoes in the solution 36 hours. Dry the mass between blotting paper and subject to great pressure.

WAX FOR BOTTLE SEALING.

Mix rosin or cheap sealing wax with an equal amount of beeswax in a water-bath. Dip bottles in hot solution and lay on side until dry.

REMOVING HARD RUBBER SCRATCHES.

To remove scratches from hard rubber pass a heated soldering copper over a thickness of paper laid on the surface of the rubber.

BATTERY WAX.

A black wax for use in plugging up the top of dry cells and coating the tops of carbons is composed of paraffine, 8 parts; pitch, 1 part; lampblack, 1 part. Heat the compound and stir until thoroughly mixed. Then apply with a brush or dip the parts into the warm fluid.

MOULDING COMPOSITION.

To produce a cheap composition for moulding frames, ornaments, etc., take 12 parts of whiting, 6 parts of fine-sifted sawdust and 1½ parts of linseed oil cake. Knead all to a stiff paste with a strong solution of glue.

WAX FOR METAL PATTERNS MAKING PLASTER CASTS.

The following is a very good wax for metal patternmakers use. Rosin, 1 part; beeswax, 1 part; plaster of paris, 1½ parts. Heat the wax and rosin and stir in the plaster of paris, then add lampblack to make the desired color. Apply this wax with a heated knife.

After taking an impression of a casting with plaster of paris, and by pouring vinegar around the edges, the plaster will loosen so that the cast can be removed without injuring it. If you want the plaster to set slow add some vinegar while mixing it.

ASPHALT COMPOSITION.

Mineral pitch, 1 part; bitumen, 11 parts; powdered stone or wood ashes, 7 parts. *Asphalt Mastic* is composed of nearly pure carbonate of lime and about 9 or 10 per cent of bitumen. When in a state of powder it is mixed with about 7 per cent of bitumen or mineral pitch. The powdered asphalt is mixed with the bitumen in a melted state along with clean gravel, and consistency is given to pour it into moulds. The asphalt is ductile, and has elasticity to enable it, with the small stones sifted upon it, to resist ordinary wear. Sun and rain do not affect it, wear and tear do not seem to injure it. It is also a most excellent roofing material when rightly applied.

Glass and Glass Working.

USEFUL GLASS WORKING FORMULAS.

1. *Glass Polishing Paste*—Prepared chalk, 9 oz.; white bole, ½ oz.; jewelers' rouge, ½ oz.; water, 5 oz.; alcohol, 3 oz. Mix into a paste. To clean and polish windows or mirrors, moisten a cloth with alcohol, place a quantity of the paste about the size of a bean on the glass and rub over the surface with the cloth until dry and powder is removed.

2. *To Cut Glass Without a Diamond.*—Glass may be cut under water with a strong pair of scissors or shears. Mark the part that is to be cut away with a heavy black line, then sink it with one hand under water as deep as you can without interfering with your view of the line and with the other hand use the scissors to cut away the part that is not required.

3. *To Drill Holes in Glass.*—Bank the spot with a wad of putty. Make a hole into the putty down to the glass and of the size wanted. Into this pour melted lead and the piece will drop out. Use broken drill and turpentine.

4. *To Engrave on Glass.*—Apply a thin coating of wax to the glass with gentle heat. When cool draw the design on the wax with a hard-pointed instrument so it penetrates through to the glass. Apply an aqueous solution of hydrofluoric acid to the design with a soft brush. Apply several times to get deep outlines. Finally wash the acid off and remove the wax by heat.

5. *Imitation of Ground Glass.*—A paint for imitating ground glass is made by rubbing down some zinc oxide with linseed oil on a slab to a thick cream. Apply to the glass thinly and stipple with a stiff brush.

Another method is the following: Paint the glass with the following varnishes: Sandarac 18 drams, mastic 4 drams, ether 24 drams, benzine 6 to 18 ounces. The more benzine the coarser the grain of imitation glass will be.

6. *To Make Window Glass Sun Proof.*—Pulverize gum tragacanth and let it dissolve for 24 hours in the white of eggs, well beaten. Lay a coat of this on the window panes with a soft brush, let it dry, and you will have a coating the rays of the sun cannot penetrate.

CEMENTING GLASS TO METALS.

(1) A cement of great adhesive property, particularly serviceable in attaching the brass mountings on glass lamps, as it is unaffected by petroleum, may be prepared by boiling 3 parts of rosin with 1 part of caustic soda and 5 parts of water, thus making a kind of soap which is mixed with one-half of its weight of plaster of paris. Zinc white, white lead, or precipitated chalk may be used instead of the plaster, but when they are used the cement will be longer in hardening.

(2) A cement for such purposes as fixing metal letters to glass windows consists of copal varnish 15 parts, drying oil 5 parts, turpentine 3 parts, oil of turpentine 2 parts, liquefied marine glue 5 parts. Melt in a water bath and add 10 parts dry slaked lime.

(3) Brass letters may be securely fastened on glass windows by the following recipes: Litharge 2 parts, white lead 1 part, boiled linseed oil 3 parts, gum copal 1 part. Mixed just before using this, forms a quick drying and secure cement.

(4) One pound of shellac dissolved in a pint of strong methylated spirit, to which is to be added 1-20 part of a solution of india rubber in carbon bisulphide.

(5) Take 2 ozs. of a thick solution of glue and mix with 1 oz. of linseed oil varnish, or ¾ oz. of Venice turpentine. Boil together, agitating until the mixture becomes as intimate as possible. The pieces cemented should be fastened together for a space of 48 to 60 hours.

(6) One of the best cements for uniting glass to other substances is prepared by putting the best and purest gum arabic into a small quantity of water and leaving it till next day, when it should be of the consistency of treacle. Calomel (mercurous chloride or subchloride of mercury) is then added in suitable quantity, enough to make a sticky mass being well mixed on a glass plate with a spatula. No more is to be made than that required for immediate use. The cement hardens in a few hours, but it is wiser to leave it for a day or two. To insure success it is necessary to use only the very best gum; inferior sorts are absolutely useless.

(7) Before glass can be soldered to metal it must be "quicked" upon the side that is to be soldered. The "quicking" process is similar to, if not identical with, the method of silvering a looking glass. When the glass is "quicked" it may be readily soldered to the metal, using Venice turpentine or chloride of zinc as a flux.

(8) Sixty parts starch, 100 finely pulverized chalk are made into a mixture with equal parts of water and spirit, and the addition of 30 parts Venice turpentine, taking care to agitate the mass with a stick, so as to insure its homogeneity.

(9) Four parts glue melted with the least possible quantity of water, 1 part Venice turpentine will resist moisture.

(10) That solder in some form adheres to glass is well known and practised by the makers of fictitious jewelry. These are made up of pieces of black glass, cut and polished, and fairly soldered on to metal plates. By breaking one of these across it will at once be seen how strong the adherence really is. If the work has been well done the pieces of glass do not fly off, but are difficult to remove except in fragments. This soldering is done as follows:

The shields, or metal plates, are coated with the appropriate pieces of glass, are laid on an iron plate, heated to the melting point of the tin. The piece of hot glass The shields, or metal plates, are coated with a thick layer of tin; these, together to be soldered is then picked up with forceps and its edge introduced under the surface of the melted stratum of tin and slid forward so as to carry some of the metal before it, thus skimming off the oxidized surface so as to bring clean glass and clean metal in absolute contact. No glue must be used; the least trace of oil or resin will spoil the operation. When the piece of glass is fairly in place it is pressed down in order to squeeze out the surplus solder. It is this sliding action that insures success; if the glass were to be directly pressed down upon the tin solder no adhesion would take place at all from the presence of a trace of oxide and the existence of an air film. The glass, of course, must be polished and perfectly clean.

(11) Beeswax and Venetian turpentine in varying proportions, depending upon consistency desired.

A GOOD GLASS CEMENT.

Formula No. 1.

Pulverized glass, 10 parts; powdered fluorspar, 20 parts; soluble silicate of soda, 60 parts. Both glass and spar must be of finest powder; the mixture must be made by quick stirring, and when incorporated, must be used at once.

Formula No. 2.

This is used for mending valuable articles of glass. A strong solution of gelatine, to which is added for every 5 parts of gelatine 1 part solution acid chromate of lime. The mixture becomes insoluble in water under the action of light. In consequence of the partial reduction of the solution, cover the surfaces to be united as evenly as possible; press them together and tie them. Expose the glass to the sun a few hours. Boiling water has no effect on the oxidized cement, and the fracture can scarcely be recognized.

MAKING MIRRORS BY ELECTRICITY.

A rapid and admirable method for depositing suitable metals on the surface of glass so as to produce mirrors consists of decomposing the metal by means of a high potential electric current. It is thus described in the *Physikalische Zeitschrift* by G. Rumelin.

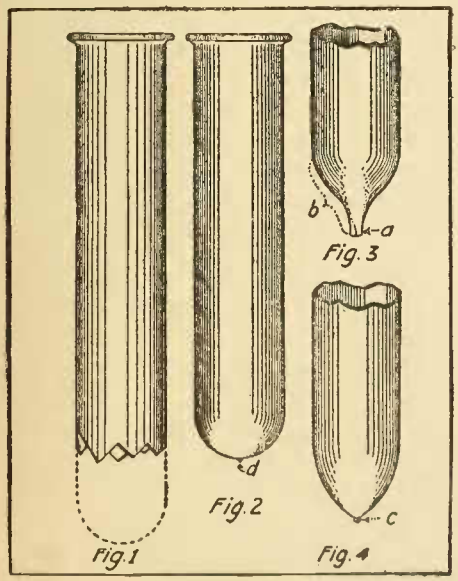
A metal plate is placed in juxtaposition with the glass plate which is to receive the coating. The two plates are then placed flat on a table beneath the receiver of an air-pump suitable for producing a high degree of vacuum, such, for example, as the rotary molecular pump of Gaede.

A small quantity of an inert gas, such as hydrogen, is introduced into the vacuum and a high potential current is then turned on by means of the negative pole of a suitable source of electricity, this pole being attached to the metal plate. Thirty seconds duration of this cathodic flow is sufficient to obtain a properly silvered mirror.

Besides silver such metals as gold, copper, platinum, nickel, iron, paladium and iridium may be employed.

REPAIRING TEST-TUBES.

A very good method of repairing broken test-tubes is described herewith:



Don't Throw Away Your Broken Test-Tubes. You Can Repair Them Easily. Just Try!

The broken test-tube was lowered into the Bunsen flame and the jagged edges, when soft enough, (still held in the flame) were pulled out with the aid of an ordinary pair of pliers. When the walls seemed thin enough, the jagged edges were drawn together thereby closing the end of the tube as in Fig. 3. The heat was concentrated on "b," Fig. 3, and when soft enough the tip "a" was drawn out (*while held in the flame*).

The result appears at Fig. 4. Still holding the tube in the flame, the bottom was heated until soft when it was quickly removed, the open end placed to the mouth, and the breath forced into it. This was done several times until the bottom assumed the shape of that at Fig. 2. Then it was annealed well in the luminous flame and set aside to cool. The result is a test-tube that may be used for all ordinary purposes not requiring heat. The tube may also be used in the flame if the tip of thick glass "d," Fig. 2, is removed with the aid of a grinding wheel or an oil-stone and the tube re-heated and annealed again.

The jaws of the pliers must be hot when it comes in contact with the hot glass and preferably one with narrow jaws and insulated handles. Before introducing the broken test-tube in the flame it must be well heated in the air above the flame to prevent further cracking.

PENCILS FOR WRITING ON GLASS.

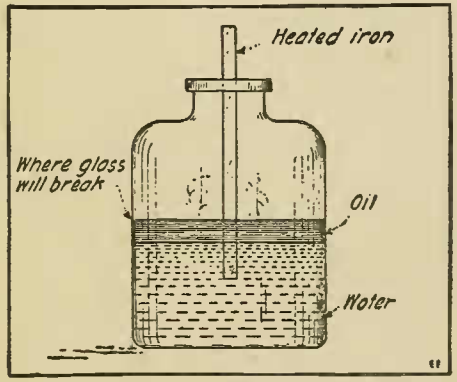
Stearic acid, 4 pts.; mutton-suet, 3 pts.; wax 2 pts.; melt together and add 6 parts of read lead and 1 pt. purified carbonate of potassa, previously triturated together; set aside for an hour in a warm situation, stirring frequently; then pour into glass tubes or hollow reeds.

A GOOD CLEANING SOLUTION FOR GLASSWARE.

A good cleaning solution (chromic acid) may be made by dissolving potassium or sodium chromat in concentrated sulphuric acid, until a saturated solution results. Apparatus to be cleaned should be covered with a thin layer of this solution, and rinsed with water.

HOW TO CUT LARGE BOTTLES.

Here is a novel way to cut large glass bottles so as to make jars. Procure a large bottle. If the top is not level or tapers it can be cut by the following



A Simple Way to Cut Off Large Glass Bottles, by Plunging a Red-Hot Iron Into an Oil and Water Solution Filling the Bottle Up to the Line Where the Cut Is to Be Made.

means: Pour water into bottle within 1 inch of line where you want to cut. Then slowly pour linseed oil in up to the level of proposed cut. Then a red-hot iron plunged vertically into the oil will cause the glass to crack at the level of the liquid and leave an open top jar.

REMOVING GLASS STOPPERS.

Take a piece of wood about 12 inches long, 1 inch wide and ⅛ inch thick (an ordinary light ruler is just the thing), hold the bottle upright, either on the bench or in the hand, tap the under side of the shoulder of stopper a few minutes with the edge of the piece of wood or rule, first one side and then the other, says *The Amateur Photographer's Weekly*. It will then be found that it is quite easy to remove the stopper with the fingers.

HINTS ON DRILLING GLASS.

Drilling glass is a difficult proposition and very few amateurs possess tools suitable for this purpose. The following apparatus will drill holes, varying in size from the smallest up to an inch or more.

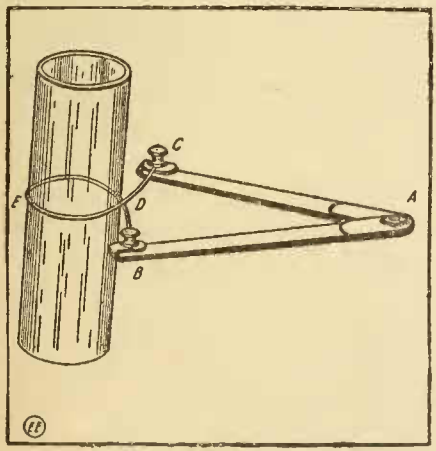
First procure a brass tube the outside diameter of which measures the same size as the desired hole. Revolve this on the surface of the glass, either by hand or better by means of a small hand drill. The drilling must be started by allowing the lower end of the tube to be guided by a wooden block, with a hole cut in it the size of the tube. After the tube has passed through the glazing this guide can be removed. An excellent abrasive for this drill is emery dust and turpentine. It is an excellent idea to drill from both sides, since this results in a clean, smooth hole.

ELECTRIC GLASS JAR CUTTER.

Procure two brass or iron rods, 7 in. long by ¼ in. diameter. Flatten them out slightly at both ends and drill holes, just large enough to pass a battery bolt, ¼ in. from the ends as shown.

Notice that at one end the rods are flattened for about ¾ in. so that they can be almost closed. The rods are fastened together at A with a battery bolt and two nuts. A third nut serves to hold the wire lead. The arms should work smoothly. Battery bolts are inserted at B and C and a piece of German Silver or other resistance wire, connected at B, forms a loop and in turn is connected at C. The length of wire and size remains with the experimenter, depending upon the current available. No. 22 German Silver wire will suffice for use on a step down transformer of about 8 volts.

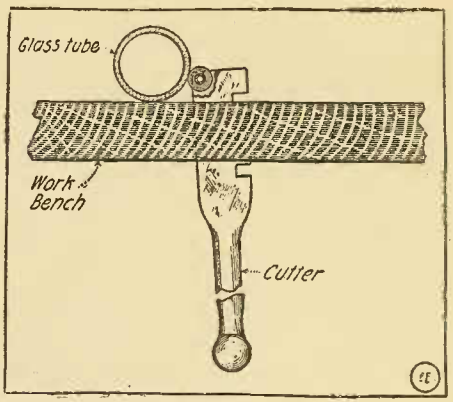
To cut a glass jar, grip the instrument in the right hand with the two fingers between the two arms so that they can be spread further apart if necessary. The loop of wire is placed around the jar at the point at which it is to be cut and held taut. One lead from the source of current is connected at A and the other is held in the left hand and touched at point E on the wire for a few seconds. For best results the wire should almost reach a red heat. After being left in place for a few seconds dash a little cold water against the heated glass. A clean break should result.



An Electric Glass Tube and Jar Cutter—Current Is Past from "E" to "A", Heating Wire, when Glass Is Wetted at the Point where Wire Encircled It.

HOW TO CUT GLASS TUBES.

A good way to cut glass tubes with the ordinary glass cutter is to bore a hole in your work bench and fit a glass cutter in it with the handle down, so that the wheel is about one eighth of an inch above the level of the bench. Lay the tube to be cut against the cutting wheel of the glass cutter and turn with the hand as shown in the illustration. This scores the glass so that the tube may be easily broken with the hands.



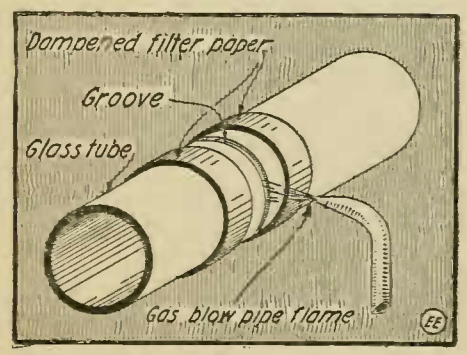
Cutting Glass Tubes Is Always a Problem to the Amateur. Here's a Simple Method Using an Ordinary Glass Cutter.

THE WHEEL GLASS-CUTTER.

Many experimenters have at some time or other occasion to cut glass, and no doubt most of them use the wheel-cutters, which are soon thrown away as of no use. Perhaps the following tip will be of service to them. I had occasion to cut some glass a few days ago, and had only an old, and, as I thought, worn-out wheel to do it with. I tried dipping it in a drop of paraffin, and was astonished to find that it cut as well as when new. I experimented with two others which I had discarded, and found that they cut equally well. Turpentine seems to answer the same purpose.

HOW TO CUT GLASS TUBING.

To many, or rather most experimenters, it is a difficult thing to cut glass tubing larger than a half inch in diameter. Sizes under this can be broken after being cut or nicked slightly with a file. The method explained here is that used in most chemical laboratories. To illustrate, say the tube is about an inch and a half or so in diameter. The required length of tubing is measured off and then a groove is cut around the tube with the corner of a file. This must be rather deep. Then a piece of filter paper is folded so as to be about two inches wide and long enough to go around the tube. The paper is then moistened. This and a similar piece are placed one on each side of the groove, leaving about a quarter of an inch between the two. A flame from a bunsen burner or blow pipe is then applied to the groove and it will be found that the tube breaks evenly along the file cut. Another method that can be used on smaller tubing, about half inch in diameter, is to make a cut as described and then apply a red hot piece of iron to one spot on the cut.

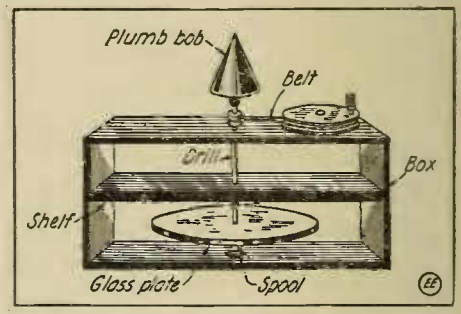


Easy Way to Cut Glass Tubing.

(A very simple method to accomplish the above is the following: Take a thick piece of string and soak it well in alcohol. Tie it around the part where tube is to be cut. Now light the string. The second it extinguishes dash a drop of cold water on it. A sharp, even break of the tube is the result. We have thus "cut" off the necks of large bottles.)

AN EFFICIENT PLATE GLASS DRILL.

In making a static machine, it is preferable to have the glass plates drilled in the exact center to allow passage of the spindle or axle, but the accomplishment of this task



Simple Home-made Apparatus for Drilling Holes in Plate Glass for Static Machines, Etc.

is a stumbling block to the amateur constructor and even difficult for those more skilled in workmanship. However, the simple drill apparatus shown herewith will do the trick very nicely and, while a little patience is necessary, the excellent results will more than compensate for the time and energy expended.

First procure a wooden box, size about 17" x 10" x 7" and force out the top and bottom of the same, after which construct a shelf as shown. Then drill through both the top piece and this shelf a hole, size of which should be of such a diameter as to allow the tube of an ordinary curtain rod to revolve freely and not too loosely. Take the brass rod that was inside of this tube, cut off a piece about 6" in length and insert one extremity into the bore of a carpenter's plumb bob. This latter should be as large as possible and weigh at least one pound. Now, saw off both ends of an ordinary thread spool and then glue together in such

a manner as to form a pulley, after which fasten rigidly to the top of the drill, directly underneath the plumb bob. To give greater speed to the drill, make a larger pulley as shown and connect together by means of a leather belt. However, this method will not be found very satisfactory, as the stretching tendency of the leather will in a short time cause the belt to slip and thus prevent motion entirely. A better and simpler way is to merely hold the belt at both ends, fit into the groove of the small pulley, and then pull forward first with one hand and then the other, which action will give a continual alternating circular motion to the drill.

When everything has been completed, insert the rod, to which the plumb bob is attached, into the drill or tube, being careful beforehand to pour in a small quantity of emery. In as much as this substance is difficult to get in a loose form, it is suggested that the reader buy a few sheets of regular emery paper. These should first be torn up in small pieces, then put in a metal pot or pan and finally set fire to. The paper will burn away, leaving the emery grains, which can be easily separated from the paper ash by sifting through a fine strainer. For the purpose of raising the glass plate upward so that the full weight of the plumb bob is brought to bear, glue a large thread or cotton spool to its center. As the hole of the latter can be seen through the glass, this will also act as a guide in drilling.

From time to time, in operating this drill, add a little machine oil to the emery in order to provide a lubricant and thus prevent the glass from cracking. Also roughen the end of the drill with a file, so as to give it a sharper and therefore better cutting edge.

HOW TO CUT THE TOP OFF A BOTTLE.

Cut a piece of filter or blotting paper in two narrow strips, moisten same and paste around the bottle, each piece of paper parallel to the other, leaving between them a narrow space, marking the place where you want to cut the bottle. Now hold the bottle over the flame of a spirit lamp and turn slowly so that the bare space is heated evenly; after about a minute the glass will break quite clean and will only need to be filed smoothly to take off the sharp edges.

HOW TO FROST OR COLOR LAMP BULBS.

Dip the bulb in a thin solution of white shellac and alcohol, which gives it a frosted appearance. Add diamond dyes of the desired shade to the solution for colors.

Inks.

INK FORMULAS.

1. Ink for Porcelain:—Colophony resin, 20 parts; Borax, 35 parts; Alcohol, 150 parts; Water, 250 parts. Nigrosine in sufficient quantity. Dissolve the resin and nigrosine in the alcohol and the borax in the water and mix both solutions.

2. Stamping Ink:—Manganese phosphate, 30 parts; Hydrochloric acid, 60 parts; Anthracence, 15 parts; Potassium chromate, 7.5 parts; Gum acaia in sufficient quantity; Water, 7.5 parts. Dissolve the manganese phospate in the hydrochloric acid, make a mixture of the anthracence, potassium chromate and water, and shake. Mix the whole vigorously, adding sufficient gum acaia to maintain suspension.

3. Typewriting Ink:—Transparent soap, 1 part; Glycerine, 4 parts; Water, 12 parts; Alcohol, 25 parts; Aniline dye, sufficient quantity. Dissolve the soap in a mixture of the glycerine and water by aid of heat, and finally the aniline dye dissolved in the alcohol.

4. Red Typewriting Ink:—Bordeaux red, 1 part; Aniline red, 15 parts; Oelic acid, 45 parts; Castor oil, sufficient quantity, approximately 1,000 parts. The coloring matters are triturated with the oelic acid. The castor oil is then added and the whole heated at 100 to 110 degrees, under constant agitation.

5. Red Copying Ink:—Extract of logwood, 80 parts; Water, 1,000 parts. Dissolve with the aid of heat under constant stirring and add Potassium bichromate, 10 parts. After solution is effected add nitric acid, 30 parts. After shaking thoroughly add to thicken dextrin, 60 parts; water, 60 parts; salicylic acid, 1.5 part.

6. Universal Ink:—Extract of logwood, 16 parts; Hot Water, 200 parts. To the solution add Chrome alum, 16 parts; Potassium chromate, 660 parts.

7. Black School Ink:—Extract of logwood, 8 parts; hot water, 180 parts. To the solution add Potassium bichromate, 1.3 parts; hot water, 20 parts; Hydrochloric acid, 3.5 parts.

8. Indelible Ink:—Extract of logwood, 20 parts; boiling water, 280 parts. After solution has been effected, mix it with a liquid composed of solution of Potassium bichromate, 3.5 parts; hot water, 20 parts; Hydrochloric acid, 8 parts.

INK RECIPES.

Everlasting Black.—Tannic acid, 1 oz.; crystal gallic acid, 77 grs.; sulphate of iron, 5 drs.; gum arabic, 100 grs.; dilute muriatic acid, ½ oz.; Carbolic acid and water (acid 10 drs.; water, 1¼ pints). Mix the acid and water and dissolve the other ingredients therein. This ink will not fade.

Red Ink (Bright).—Dissolve 25 parts of saffron in 500 parts of warm glycerin, then stir carefully in 500 parts of alcohol and 500 parts acetic acid. It is then diluted with 9,000 parts of water, to which a little gum arabic may be added.

Gold Ink.—Fine bronze powder is mixed with a little sulphate of potash and water; the precipitate is mixed with water and a sufficient amount of gum.

Green Ink.—Rub 3 drs. of Prussian blue and 6 drs. gamboge with 4 ozs. mucilage and a pint of water.

Silver Ink.—Silver leaf ground with a little sulfate of potash is washed from the salt and mixed with water and a small amount of gum acacia.

White Ink.—Triturate together one part honey and two parts of dry ammonia alum. Dry thoroughly and calcine in a shallow dish over a fire until perfectly white. Cool, wash, rub up with sufficient gum and add water for use as ink.

Vanishing Ink.—This ink consists of an aqueous solution of iodide of starch. Characters written with it completely vanish in about four weeks.

GOOD INK FORMULAE.

These two formulae obtained through original experiments, have been found to produce excellent inks. The ingredients are easily obtained and at little expense. Rain water may be used in place of distilled water thus removing the need of having any chemical apparatus. The resulting inks are each of a beautiful color, make a permanent record, flow easily, and do not corrode the pens. The blue ink can be used successfully and safely in the most delicate of fountain pens.

Blue Ink:—Dissolve one ounce of soluble prussian blue in one quart of cold distilled (rain) water. Add to this solution, 5 grams of oxalic acid. Then filter the solution through filter or blotting paper.

Black Ink:—Dissolve one ounce of extract of logwood in one quart of boiling water. When cold, add one-fourth ounce of potassium bichromate and one gram of sodium carbonate. The addition of one-fourth ounce of prussian blue improves the solution. This ink will cost about 5 cents.

A FEW USEFUL INK FORMULAS.

Blue ink:

3 parts Prussian blue.
1 part Oxalic acid.
30 parts water.

When dissolved add 1 part of gum arabic.

Green ink: Sap green dissolved in very weak alum water.

A good ink eraser:

A. Oxalic acid mixed with citric acid may be used.

B. Equal parts of cream of tartar and citric acid in solution with water.

Inks that appear through heat:

A. A weak solution of nitrat of copper; when heated it becomes (Red).

B. With a solution of sulphuric acid (Black).

C. With lemon, onion, leek, cabbage or milk and will be visible when paper is heated.

D. With a weak solution of nitrat of mercury (Black).

Invisible ink:

A. Write with pure dilute tincture of iron and develop with a blotter moistened with strong tea.

B. Linseed oil ..... 1 part
Ammonia ..... 20 parts
Water ..... 100 parts
Mix well before using.

Vanishing ink:

To make an ink black at the time but that will disappear in 24 hours: Boil nutgalls in alcohol, add copper sulphate and sal ammoniac, let cool and then dissolve a little gum in it.

BLUE INK FOR USE ON GLASS.

A blue fluid for writing on glass which is not attacked by water is made as follows: Bleached Shellac, 10 parts; Venice Turpentine, 5 parts; Oil of turpentine, 15 parts; Powdered Indigo, 5 parts. Mix the shellac, oil of turpentine, and place in water bath under gentle heat until solution takes place. Then add the indigo.

INK POWDER.

A good ink powder to be thinned with water can be made from the following: Malachite Green Crystals, one part; Fuchsine, one part; Lump Gum Arabic, one part. The Gum Arabic should be partly pulverized.

INK RECIPES.

(1) Black Writing Ink.—Take 6 ounces of the best gallnuts and pound them in a mortar or otherwise. Take 4 ounces of logwood and let it be cut or ground into very small pieces; these, mixed with 4 quarts of rain water, must be boiled together until half diminished. Then take 2 ounces of copperas made into a powder, and 3 ounces of gum arabic; let these be also mixed and strained through a linen cloth. After this mixture has stood a few hours it may be written with.

(2) Green Writing Ink.—Dissolve 1 ounce of Hoffman's Permanent Malachite Green in 1 gallon of hot water; add a little gall and alcohol. Reduce with cold water to the required shade.

(3) Sympathetic Ink.—An ordinary solution of gum camphor in whiskey is said to be a permanent and excellent sympathetic ink. The writing must be done quickly, as the first letters of a word have disappeared by the time the last are written. Dipping the paper in water brings it out distinctly, and it becomes invisible again when the paper is dried. It can be brought out repeatedly without affecting its vividness.

SILVER AND GOLD INK.

A beautiful gold ink may be made as follows:

Honey and gold leaf, equal parts; add turpentine until the gold is reduced to the finest possible state of division. Agitate with thirty parts hot water and allow to settle; decant the water and repeat the washing several times and finally dry the gold leaf and mix it with a little gum water for use.

Silver Ink.—For silver ink the process is the same as for gold, substituting silver leaf for the gold leaf.

Luminous Ink.—The following ink is luminous or shines in the dark: Phosphorous, ½ dram, oil of cinnamon, ½ ounce. Mix in a vial, cork tightly and heat slowly until mixed.

A letter written in this ink can only be read in a dark place, when the writing will have the appearance of fire.

A GOOD WRITING FLUID EASILY MADE.

A good writing fluid, of a rich, dark black, can be put up by following this formula:

Two and four-tenths grams of logwood extract, should be mixed with 100 cubic centimeters of distilled water.

Heat should be applied until the substance is dissolved. After it is cooled potassium chromate should be added, until the desired shade is attained. From 2 to 3 c.c. is usually sufficient. A little gum arabic, or gelatine, may be dissolved in the matter to give it a good consistency, or "body."

If this method is followed the solution should then be filtered through silk. This finishes the fluid, and it is ready for use.

For Users of Fountain Pens.

There is always a great difficulty in unscrewing a fountain-pen for refilling. You will find, however, that if the threaded piece of the pen is slightly greased with a little vaseline the parts will unscrew much easier, and the contained ink cannot leak out, thus eliminating soiled fingers.

VIOLET INK.

Primula Violet, 1 1/6 ounce. Distilled boiled water, 3 quarts. This can be converted to copying ink by adding 4 ounces glycerin.

Primula violet is known as Hoffmans violet. The finest shade is No. 6. Other shades can be made from other colors. Add about 5 per cent alcohol and 1 to 4 per cent glycerin to keep.

INK-ERASING BLOTTER.

Take an ordinary sheet of thick blotting paper and steep it several times in a solution of oxalic potassium, and dry. While the ink spot is still moist apply the blotter, and the ink will be entirely removed. If the ink is dry moisten and apply the blotter.

INK THINNER.

If your drawing ink clots or gets lumpy from standing open, add some aqua-ammonia and shake well.

SYMPATHETIC INKS.

(1) *Rub Out Ink.*—This ink is named "Rub Out" Ink because it can be rubbed out more easily than it is written with on paper. Take common starch and dissolve it in water and then add some iodine. Shake well before using and write as with regular ink. When dry, it has a purple color and can be erased by simply passing a clean cloth lightly over the paper and leaves no trace on the paper.

(2) A dilute solution of sulphuric acid when heat is supplied, produces fine black characters. Use H_2SO_4 (1) Part to H_2O (20) parts.

(3) Combine (1) and (2) and you have the "disappearing reappearing" ink. Use in this way. First write on paper with the mixture of (1) and (2). Then rub out. The writing is not to be seen any more but you can immediately cause it to appear by slightly heating the paper.

(4) If you have not any sulphuric acid at hand to make (2) with, use lemon juice or acetic acid, or citric acid or any harmless acid.

(5) A dilute solution of chlorid of copper used for writing is invisible until the paper is heated, when the letters are seen of a beautiful yellow, disappearing with the heat which develops them.

(6) Weak solutions of nitrat of silver and gold chlorid when exposed to the sun become dark brown and purple respectively.

(7) Potassium ferrocyanid, one part, is dissolved in distilled water, twenty-five parts. When dry lay over the writing a blotter moistened with a dilute solution of ferric chlorid (tincture of iron will answer).

(8) Solutions of cobalt chlorid or the nitro-chlorid yield tracings which become green or blue when heated and disappear again as the paper cools.

(9) Boil some gall-nuts in aqua-fortis and to the infusion add some gum arabic and a little sulphuric acid. However plain the ink may be at first, it will entirely disappear from the paper in a few days.

SYMPATHETIC INKS.

Below are given the formulæ for making sympathetic inks:

Formula No. 1.

Take some pure lime juice, or lemon will do, and write with it on a paper. Then heat over an alcohol lamp and the writing will come out brown.

Formula No. 2.

Dissolve some sulphate of iron in water and write with it. Heat and the writing will come out dark brown or black.

Formula No. 3

Dissolve some chlorate of potash in water. Write with it and heat. The writing will come out brown.

Formula No. 4.

For purple invisible ink. Take some salicylate of soda and dissolve in water; don't make the solution too strong, or it will turn brown where you write with it. Reagent. About 50 per cent solution of tincture of iron applied with a brush. The writing will come out purple.

"HANDY" WATER PEN.

Take best quality violet aniline, reduce to a thick paste with water, then add mucilage and mix thoroughly; apply the paste thus made to the pen and let it dry 12 hours. Any steel pen may be prepared in this way. Directions for using: Start action by dipping in water up to filling. If pen should be greasy, wet point with the tongue. To make the ink flow thick, dip to the filling, if wanted thin or pale, dip only to the eye of pen after starting. After using throw water off, but don't wipe it, for it will dry in a minute.

ACID INK ERADICATOR.

An ink eradicator quite as good as those manufactured is given below:

Add 110 grams of *chloride of lime* to 1 *liter of water;* let the solution stand for 24 hours, then strain through fine cloth and add 10 *parts acetic acid* to each 25 parts of solution.

To erase ink, apply with reverse end of a penholder, and dry with a blotter.

FORMULAE FOR INVISIBLE INKS.

No. 1.—20 parts water, 1 part sulphuric acid. Add the acid to the water and not the water to the acid. Unless care is taken that this is done, the heat developed by the dissociation of the acid may break the vessel. Use with a clean steel pen, and when writing is dried it will become invisible, unless the pen has scratched the surface. To read, hold the paper for a moment near a red-hot stove or before a gas flame.

No. 2.—1 oz. citrate of potash, 5 oz. water. Make a complete solution and use same as No. 1.

Sympathetic Ink.

Dissolve chloride or nitrate of cobalt in water. When warmed slightly before a fire the writing will show; on exposure to moist air it will disappear.

FINE INK AND MAGIC PAPER.

Fine Ink.—This experiment is most effective in a dark room. Dissolve ½ teaspoonful of potassium nitrat in a little water (about 1½ teaspoonfuls). Now use this liquid as an ink, writing on unglazed paper any design, making broad and heavy strokes and be sure to connect all lines. When the paper is thoroughly dry, apply a light to the end of the writing—putting out any flame that arises. If all directions have been carefully followed a glowing spark will travel the length of the design.

The effect is most mysterious and best results are obtained by using soft paper and writing all lines broad and heavy.

Magic Paper.—If some people don't believe you can write black lines with plain water show them this experiment:

On a sheet of writing paper rub this mixture—equal parts of tannic acid (powder) and tannic ammonium sulphate thoroughly mixed. After the mixture has been rubbed into the paper blow off all remaining particles. The paper is now ready. Write with a clean pen, dip in water and black lines will appear.

INVISIBLE INK RECIPES.

Recipe No. 1.—Writing fluid: 1 drachm potassium iodide; enough water to make 1 ounce. Reagent: A strong solution of bichloride of mercury; apply with a brush and the writing will come out red.

Recipe No. 2.—Writing fluid: 1 drachm potassium ferrocyanide; enough water to make 1 ounce. Reagent: 1 drachm perchloride; enough water to make 1 ounce, or 50 per cent solution of tincture of iron; apply with a brush and the writing will come out blue.

Recipe No. 3.—Writing fluid: 1 drachm cobalt chloride; enough water to make 1 ounce. Reagent: Heat, and the writing will be blue.

A small amount of acacia gum added to the writing fluids will improve the writing quality. Number one is preferred because it is easier to get, the paper is unstained and the writing can be erased by simply heating.

INK FOR WRITING ON METALS.

Formula:

Muriatic Acid ..... 1 oz.
Nitric Acid .....½ oz.

Cover the portion of the metal you wish to write upon with melted wax and allow to cool. Write the inscription plainly with any sharp instrument through the wax to the metal.

Apply the mixture with a feather or rag, carefully filling each letter, and let it remain from 1 to 30 minutes, according to the depth desired; after which wash off the wax and mixture, and rub over with a little sweet oil to prevent further tarnish or rust.

MAGIC INK RECIPES.

Red Ink.—One drachm potassium thiocyanate to one-half ounce of water. Reagent—One-half ounce of ferric chloride to one ounce of water. Apply with a mop or brush and writing will appear red.

Blue Ink.—One drachm potassium ferrocyanide to one ounce of water. Reagent—Fifty per cent solution of ferric chloride or other ferric salts.

Blue Ink.—One drachm potassium ferrocyanide, otherwise called red prussiate of potash (note, not ferrocyanide, which is yellow prussiate of potash), to one ounce of water. Reagent—Strong solution of ferrous sulphate.

Black Ink.—Tannin (strong solution) for the writing solution. Reagent—Very strong solution of ferrous sulphate.

Glycerine gives the ink more "body."

INDIA INK.

Grind fine lampblack and gelatine, scent with camphor or musk essence and mold in sticks. It can be improved by washing the lampblack with a solution of caustic soda and then straining off the solution or drying it out.

FLUORESCENT WRITING.

If we dissolve some sulphate of quinine in water and then draw a design or write some motto or sentence on a piece of white paper with the solution and allow it to dry the drawing or design will be absolutely invisible.

But if this same piece of paper be illuminated by the light of a Geissler or vacuum tube then the design or writing will at once appear as if written or drawn with a beautiful blue ink.

INDELIBLE INK FOR GLASS OR METAL.

Borax, 1 oz.; shellac, 2 oz.; water, 18 *fluid* oz.; boil in a covered vessel, add of thick mucilage, 1 oz.; triturate it with levigated indigo and lampblack q. s., to give it a good color. After 2 hours' repose, decant from the dregs and bottle for use. It may be bronzed after being applied. Resists moisture, chlorine, and acids.

TICKETING INK.

Dissolve 1 oz. of gum arabic in 6 oz. water, and strain; this is the mucilage; for *black color,* use drop black, powdered, and ground with the mucilage to extreme fineness; for *blue,* ultra-marine is used in the same manner; for *green,* emerald green; for *white,* bake white; for *red,* vermilion, lake, or carmine; for *yellow,* chrome yellow. When ground too thick they are thinned with a little water. Apply to the cards with a small brush. The cards may be sized with a thin glue, and afterwards varnished, if it is desired to preserve them.

INDELIBLE STENCIL-PLATE INK.

One lb. precipitate carbonate of iron; 1 lb. sulphate of iron; 1¼ lbs. acetic acid. Stir over a fire until they combine; then add 3 lbs. printer's varnish and 2 lbs. fine book ink, and stir until well mixed. Add 1 lb. of Ethiop's mineral.

LITHOGRAPHIC INK.

Venice turpentine 1 part, lampblack 2 parts, hard tallow soap 6 parts, mastic in tears 8 parts, shellac 12 parts, wax 16 parts; melt, stir, and pour it out on a slab.

HORTICULTURAL INK.

Copper, 1 part; dissolve in nitric acid, 10 parts, and add water, 10 parts; used to write on zinc, or tin labels.

INVISIBLE INK.

Dissolve equal parts of copper sulphate and ammonium chlorid in water until it becomes light green. When heated it will turn yellow.

DRAFTING HINTS.

Tracings may be very readily cleaned and pencil marks removed by the use of benzine, applied with a cotton swab. It may be rubbed freely over the surface without fear of injury to the lines drawn in ink, or even water colors, but pencil marks and dirt will quickly disappear. The benzine evaporates almost immediately, leaving the tracing unharmed. The surface, however, will be somewhat softened and should be rubbed down with a little powdered talc or chalk before drawing more ink lines.

Always sprinkle chalk or talc on surface (dull side) of cloth, rub in with fingers, and wipe off before starting to draw ink lines.

Leather Polishes, Etc.

BLACKINGS FOR BOOTS AND SHOES.

1. *French Paste for Patent Leather.*—Take 6 drm. of *Pure Wax,* 2 oz. of *Olive Oil.* This wax has to be melted in a water bath. Mix thoroughly by stirring; heat moderately. Add ½ oz. of *Oil of Turpentine* and ½ oz. of *Oil of Lavender.* The mixture will form a paste, which should be put in boxes before it becomes cool. Apply with a linen rag. A very good paste, which keeps the leather *soft and restores the gloss.*

2. *Dressing for Tan Shoes.*—Take 1 oz. of *Annatto,* 1 oz. of *Gamboge,* 1 oz. of *Acacia,* 2 oz. of *Catechu,* 2 oz. of *Hydrochloric Acid.* Add water enough to make 40 ounces.

3. *Polish for Tan and Russet Shoes.*—1 oz. of *Dark Yellow Wax,* 3 oz. of *Oil of Turpentine,* 1 oz. of *Palm Oil,* 15 min. of *Oil of Mirban.* Melt the wax and oil together, add the turpentine, and, when nearly cool, the oil of Mirban.

4. *French Boot Blacking.*—Dissolve 150 parts of *Wax* and 15 parts of *Tallow* in a mixture of 200 parts of *Linseed Oil,* 20 parts of *Litharge,* 100 parts of *Molasses* at a temperature of 250° F. After this add 103 parts of *Lampblack.* When cool dilute the mixture with 280 parts of *Spirits of Turpentine,* and finally mix with a solution of 5 parts of *Gum Lac* and 2 parts of *Aniline Violet* in 35 parts of *Alcohol.*

5. *German Boot Blacking.*—Melt together 90 parts of *Ceresine* (or *Beeswax*), 30 parts of *Oil of Spermaceti,* 350 parts of *Asphalt Varnish.* Add 10 parts of *Borax,* 20 parts of *Lampblack,* 10 parts of *Prussian Blue,* 5 parts of *Nitro-Benzol.*

6. *Self-Shining Blacking.*—Dissolve 8 oz. of *Gum Arabic* in 8 oz. of best *Black Ink;* add 2 oz. of *Olive Oil.* Mix thoroughly and then add 4 oz. of *Strong Vinegar,* 3 oz. of *Brown Sugar,* 2 oz. of *Alcohol.*

7. *Waterproof Blacking.*—Melt together 3 oz. of *Beeswax* and 3 oz. of *Black Resin;* then stir in 1 pt. of *Boiled Oil.* When it has cooled a little add 3 oz. of *Oil of Turpentine.*

8. *Russian Waterproof Boot Blacking.*—Melt 1 oz. of *Beeswax,* ½ oz. of *Suet,* 2 oz. of *Olive Oil.* Add ½ oz. of *Lampblack* and stir until cool. Warm the boots and apply the blacking.

9. *Liquid Shoe Blacking.*—5 oz. of *Animal Charcoal,* 4 oz. of *Molasses,* ¾ oz. *Sweet Oil.* Triturate until the oil is thoroughly incorporated, then stir in ¼ pint of *Vinegar* and ¼ pint of *Beer Lees.*

10. *Finishing Blacking.*—Mix together ½ oz. of *Gelatine,* ½ oz. of *Indigo,* 1 oz. of *Logwood Extract,* 2 oz. of *Crown Soap,* 8 oz. of *Softened Glue,* 1 qt. of *Vinegar.* Heat the whole over a slow fire and stir till thoroughly mixed. Apply with a soft brush and polish with a woolen cloth.

LEATHER PRESERVATIVES.

One hundred parts *Sweet Oil,* 100 parts *Mutton Suet,* 2 parts *Turpentine.* Melt together and apply to the leather, which has been sufficiently warmed so that it will liquefy and absorb the fat. Another formula is as follows: 10 oz. *Linseed Oil,* 10 oz. *Mutton Fat,* 1 oz. *Venice Turpentine* melted together. Apply to the leather when dry and warm and it will preserve it against wet or snow.

LIQUID JAPAN FOR LEATHER.

Molasses, 8 lbs.; lampblack, 1 lb.; sweet oil 1 lb.; gum arabic, 1 lb.; isinglass, 1 lb. Mix well in 32 lbs. water; apply heat; when cool, add 1 quart alcohol; an ox's gall will improve it.

WATERPROOF OIL-BLACKING.

Camphene, 1 pint; add all the India-rubber it will dissolve; curriers' oil, 1 pint; tallow, 7 lbs.; lampblack, 2 oz. Mix thoroughly by heat.

TO REMOVE OIL STAINS FROM LEATHER.

Cover the spot with *Spirits of Sal-ammoniac;* allow it to act for a short time, cleaning with clear water; repeat until the spot is removed, taking care not to affect the color of the leather.

BLACKINGS AND POLISHES FOR LEATHER HARNESSES, ETC.

1. *Harness Blacking.*—Melt together 2 oz. of *Mutton Suet,* 6 oz. of *Beeswax.* Add 6 oz. of *Sugar Candy,* 2 oz. of *Soft Soap,* 2½ oz. of *Lampblack,* ½ oz. of *Powdered Indigo.* Mix thoroughly and add ¼ pint of oil of turpentine.

2. *Harness Blacking.*—Melt together 4 oz. of *Gelatin,* 3 oz. of *Gum Arabic,* ¾ pint of *Water.* Add when dissolved 7 oz. of *Molasses,* 5 oz. of *Fine Powdered Animal Charcoal.* Heat gently, stirring all the time until the compound is of proper consistency when cold. Must be kept corked.

3. *Polish for Carriage Harness.*—Dissolve 3 sticks of black sealing wax in ½ pint of *Alcohol* and apply with a sponge.

4. *French Blacking to Restore Soiled Harness.*—Take 4½ lb. of *Stearine* in thin sheets. Mix with 6¾ lb. of *Turpentine.* Heat in a water bath, during continual stirring; then add 3 oz. of *Animal Charcoal,* place the whole in another vessel and stir so as to prevent its crystallization. It must be warmed when using and rubbed on with a cloth as quickly as possible, giving it a very thin coat, and when nearly dry polish with a silk cloth.

5. *Waterproof Harness Paste.*—Put into a glazed vessel and melt over a fire 28 oz. of *black resin,* when dissolved add 3 oz. of *Beeswax.* When this is melted remove from the fire and add ½ oz. of fine *Lampblack,* ½ drm. of *Prussian Blue in Powder.* Stir well together and add *Turpentine,* enough to form a thin paste. Allow to cool. Apply with a sponge and polish with a soft brush.

6. *English Ball Blacking for Harness.*—1 oz. of *Lard,* 1 oz. of *Beeswax,* 8 oz. of *Ivory Black,* 8 oz. of *Sugar,* 4 oz. of *Linseed Oil,* 2 oz. of *Water.* Melt the wax and stir in the other ingredients, and when cold roll into balls and use.

7. *Vaseline Harness Composition.*—¾ oz. of *Prussian Blue in Powder,* 4 oz. of *Lampblack,* 2 oz. of *Molasses,* 2 oz. of *Soft Castile Soap.* Warm and mix together in a mortar. Then add 6 oz. of *Vaseline,* 5 oz. of *Ceres,* ½ oz. of *Yellow Resin.* Melt together and add sufficient turpentine to give proper consistency. Mix thoroughly.

8. *Oil for Farm and Team Harness.*—Melt 3 lb. *pure Tallow,* but do not heat it up to a boil; then pour in gradually 1 lb. neatsfoot oil, and stir until the mass is cold. If properly stirred, the two articles will become thoroughly mixed and the grease will be smooth and soft; if not well stirred, the tallow will granulate. Add a little bone black for coloring.

TO RESTORE SHABBY LEATHER.

Shabby leather can be much improved by either *Linseed Oil* or the well-beaten *Whites of Eggs* mixed with suitable coloring matter. The surface can be brought to a gloss by the use of a soft duster.

BRILLIANT FRENCH VARNISH FOR LEATHER.

Spirit of wine, ¾ pint; vinegar, 5 pints; gum senegal in powder, ½ lb.; loaf sugar, 6 oz.; powdered galls, 2 oz.; green copperas, 4 oz. Dissolve the gum and sugar in the water; strain, and put on a slow fire, but don't boil; now put in the galls, copperas, and the alcohol; stir well for five minutes; set off; and when nearly cool, strain through flannel, and bottle for use. It is applied with a pencil brush.

HOW TO POLISH HARD FIBER.

Hard fiber is used to a larger extent by amateurs in making wireless and electrical apparatus, but it has the disadvantage of absorbing moisture and soon becoming a poor insulator. To overcome this difficulty I used the following method: After the fiber had been cut to size, sand-papered smooth and all holes drilled, soak a piece of waste in thin white shellac and place on the center of a piece of cloth which has been soaked in boiled linseed oil. Then bring the edges of the cloth up around the waste and twist up tight until the shellac begins coming through the cloth. Then rub the fiber firmly but rapidly with a circular motion, and continue rubbing until the shellac begins to get sticky. Do not stop with the cloth resting on the fiber as it is apt to leave a spot. Before the polish is put on the fiber should be left in a warm dry place for a day or so to expel all moisture. After one layer has dried, the fiber may be rubbed with fine steel wool and another coat of polish put on. About three or four coats should give a fine mirror-like polish. This is the way the finish is put on pianos, etc., and if the experimenter is careful, he should be able to attain good results after a few trials. To keep the moisture out the fiber should of course be covered completely with the polish.

Metal-Craft.

BLACKING OF METALS.

(1) *Dead Black on Brass.*—Take two parts of *Hydrochloric Acid* and one part of *Nitric Acid.* Mix in a glass bottle and put in as much *platinum foil* as the acid will dissolve, when placed in a warm sand bath. The solution obtained is *Chloride of platinum.* Dip the article, after cleaning, in this soluton. This formula is of course expensive as ½ oz. nitric and 1 oz. hydrochloric acid will dissolve about 30 gr. of platinum, but a little of it will do a great deal of work. Very recommendable for optical instruments.

(2) *Dead Black on Brass.*—The following formula is much cheaper and mostly used for inside of tubes, instruments, etc. Take 1 part of *Alcoholic Shellac Varnish* and 1 part of *Lampblack.* Mix and thin with enough *alcohol* to make it flow freely with the brush.

(3) *Dead Black on Brass.*—A very permanent and beautiful black used in the French manufacture of arms is obtained as follows: Take a strong solution of *Nitrate of silver* and another solution of *Nitrate of Copper.* Mix the two together and plunge the brass in it. Remove and heat the instrument evenly until the required beautiful shade is obtained.

(4) *Blue Black Coating on Brass.*—Dissolve 7 oz. of *copper carbonate* in 1½ qt. of very strong *ammonia.* Dilute the solution with 1 quart of rain water and dip the article in it.

(5) *Dull Black on Copper.*—Take a solution of *Platinum chloride* and dilute same with five times its volume of distilled water (or pure rain water). Brush over the copper article with this solution and when thoroughly dry, rub off with an oiled flannel rag.

(6) *Gun Metal.*—The process for blacking gun barrels is the following: Take 2 oz. of Solution of *Nitric Acid;* 4 oz. of *Tincture of Iron,* 3 oz. of *best grade alcohol,* 3 oz. of *sweet spirits of nitre,* 1 oz. of *Blue Vitriol,* 1½ pt. of *distilled* or *rain water* and mix together. Clean the gun barrel, remove all grease, then coat freely with the mixture, using a piece of sponge. Let dry in a cool place for about 10 hours; remove to a warm place and let stand until quite dry. The barrel must be dry and not sticky or the result will be a red color. Now rub the barrel firmly with lard, then boil for about 10 minutes in water, wipe thoroughly and let cool. Scrape to remove the dead rust, wipe with a clean rag, then begin the whole process over again for six times. The barrel requires *six coats* before it can be finished by oiling.

(7) *Black Polish for Iron and Steel.*—Boil together 15 parts of *oil of turpentine,* 1½ parts of *sulphur.* Coat the article very thinly with the mixture and heat over the flame of an alcohol lamp.

(8) *Stove Blacking (Paste).*—A very permanent coating is obtained in mixing 5 parts *black lead,* 5 parts *bone black,* 10 parts *iron sulphate.* Use sufficient quantity of water to form a paste.

(9) *Stove Blacking (Liquid).*—Mix together 2½ parts of *bone black,* 2½ parts of *pulverized graphite,* 5 parts of *copperas,* water in sufficient quantity to form a liquid, creamy substance. Shake bottle before using. This is an excellent polish producing a jet black enamel adherent to the iron.

(10) *Black for Grates.*—The Berlin stove grate makers use this formula: Melt 5 lbs. *Asphaltum* and add 2 lbs. of *boiled oil,* 1 gal. of *Spirits of Turpentine.* Mix and apply with a brush.

BLUING (COLORING STEEL).

Small articles made of steel are very often blued. A very convenient method for the experimenter is to place the articles in an iron pan containing a quantity of clean dry sand over a fire.

Move the pieces around constantly until the desired color is achieved, then remove and plunge into clean oil. It is very necessary that the metal to be colored is clean.

TO GIVE STEEL A BLUE-BLACK COLOR.

At times a blue-black color is preferable to a blue. Melt together in an iron dish 10 parts of saltpeter and 1 part black oxid of manganese, and heat until a pine shaving thrown on the surface will catch fire. DO NOT ALLOW IT TO BOIL. Wire each piece of work and suspend in the mixture. Be sure that each article is completely covered. Do not let them touch the container at any point. When the desired color is obtained, wash in hot water, dry in clean sawdust and oil.

TO COLOR BRASS A STEEL-BLUE.

Dissolve 3 drams antimony sulfid and 4 oz. calcined soda in 1½ pints of water. To this add 5½ drams kermes. Filter and mix this solution with 5½ drams tartar, 11 drams sodium hyposulfite and 1½ pints of water. Polished sheet brass placed in the warm mixture will assume a steel-blue color.

TO GIVE APPEARANCE OF CASE HARDENING.

To 20 parts water add 1 part nitric acid. Immerse the piece in the solution for about 30 seconds, remove and wash in clean water and oil.

BLUINGS FOR METALS.

Blue Finish.—Clean the article very carefully. Make a mixture of 1 part of *Nitric Acid,* 10 parts of *Water.* Apply the liquid with a sponge until a blue film is produced. Wash with warm water; dry with a flannel and wipe with *Linseed Oil.*

Bluing Brass Like Steel.—Take a leaden vessel, put in some *Hydrochloric Acid* and very little of *Arsenic Acid.*

The brass article is laid in this vessel and soon assumes iridescent tints. Remove when the desired shade is obtained; wash with water and dry.

Bluing Gun Barrels.—Dissolve 4½ oz. of *Hyposulphite of Soda* in 1 qt. of *Water.* Also dissolve 1¼ oz. of *Acetate of Lead* in 1 qt. of *Water.* Mix the two solutions and bring to a boil in a stone pot. After having thoroughly cleaned the barrel coat with the hot solution, using a piece of sponge tied to a stick of wood. When color develops, wash with water, dry with a piece of flannel and finish with *Boiled Linseed Oil.*

Oxidizing Silver.—Boil the article in a mixture of 5 oz. of *Bromine,* 120 grains of *Bromide of Potassium,* 10 oz. of *Water,* in an earthenware pot for three to five minutes. Remove, dry and polish.

Bluing of Steel.—Heat the steel over a flame of alcohol and varnish with a mixture of *Prussian Blue* and *Alcoholic Shellac Varnish.* Use a thin varnish. Of course this is only an imitation of bluing, and the article has to be lacquered to make it wear.

Real Bluing of Steel.—This formula is used to blue revolver parts, vibrators, steel knives, etc. Mix carefully together 25 parts of *Trichloride of Antimony,* 25 parts of *Fuming Nitric Acid,* 50 parts of *Hydrochloric Acid.* Tie a rag to a stick and apply the mixture freely. After rubbing the article with a flannel it may be polished on a polishing head with a green oak wheel until an even, clear blue is obtained.

Revolver Barrel Bluing.—Clean the barrel with emery cloth; remove all grease with lime and polish the surface. Take fine and clean wood ashes in a muffle, put the barrel in the middle and heat the muffle to a temperature of *cherry red.* With a pair of tongs, remove the article from time to time to see if a dark blue can be obtained when cooled in the air. When the desired color is obtained take the barrel out and let it cool in the air. Finish with *Boiled Oil* and polish.

Bluing Steel.—A very simple process is the following: Melt *Saltpeter* in an iron pot. Clean and polish the steel article and dip in the saltpeter until sufficiently blued. Remove and cool at once in *Paraffine Oil.* Wipe with a flannel rag and dry in sawdust.

Bluing Silver.—The oxidizing of silver is produced by placing the articles in a solution of *Liver of Sulphur,* diluted with *Spirits of Sal Ammoniac.* Allow to remain until the desired dark blue-black tone is produced; then wash in water, dry and polish.

Durable Blue on Iron and Steel without Heat.—Take a stone pot and mix together 1 part of a ½% solution of *Red Prussiate of Potash,* 1 part of a ½% solution of *Ferric Chloride.* Dip the articles until the desired effect is produced. When dry, the articles may be lacquered.

COLORINGS FOR BRASS.

Fancy Colors.—Dissolve 4 oz. of *Hyposulphite of Soda* in 1½ pts. of *Water,* then add a solution of 1 oz. of *acetate of lead* in 1 oz. of *water.* Place the article to be colored in the above mixture, and heat very slowly and gradually to the boiling point. The brass articles become successively red, deep blue, bluish white and finally white, with a tinge of pink.

Steel Blue.—Dissolve 3 drms. of *antimony sulphite,* 4 oz. of *calcined soda,* 1½ pt. of water; add 5½ drms. of *Kermes.* Filter and mix this solution with 5½ drms. of *Tartar,* 11 drms. of *Hyposulphite of Soda,* 1½ pt. of *water.* Polish your brass article, heat your mixture lightly and then warm, place it in it. The brass article will take a beautiful steel blue color.

Iridescent Brown Color.—Take the following, and dissolve: 4 oz. of *Hyposulphite of Soda,* 1½ pts. of *water.* Add to this a solution of 1 oz. of *Sulphate of copper* in 1 oz. of *water.*

Heat gradually to the boiling point and place the object in the mixture. The brass article becomes first a fine rosy tint, then green, and finally iridescent brown.

Beautiful Greenish Color.—Dissolve 30 gr. of *Hydrochlorate of Ammonia,* 120 gr. of *Sulphate of Copper* in 1 qt. of *water.* Boil the solution and put the brass articles into it. The duration of the immersion is responsible for the intensity of the shades.

Patina.—To give brass articles an imitation of old bronze, with a beautiful green patina, use the following method: Dissolve 1 oz. of *copper* in 2 oz. of *Nitric acid,* add 15 oz. of *ordinary Vinegar, and* ½ oz. *Ammonium chloride.* The brass object is placed in this mixture for at least 4 or 5 days. Remove after this time, dry carefully and wipe with a rag and *linseed oil.*

Red Gold Coloring.—The red gold imitation used by the French workmen on brass articles is obtained as follows: Mix together 30 parts of *Alum,* 30 parts of *Nitrate of potassium,* 30 parts of *Red Ochre,* 8 parts of *Zinc,* 1 part of *Table salt,* 1 part of *Sulphate of iron.* This mixture is applied with a soft brush and the article is placed over a clear charcoal fire, until the salts are melted and dried, and the object assumes a brown aspect. It is then suddenly cooled in a weak solution of *nitric acid and water* containing 3 per cent of *Hydrochloric acid.* Wash afterwards abundantly in water, and dry in sawdust.

Gilding Brass.—With the following method brass may be gilded so perfectly as to resist the corrosive action of strong acid:

Dissolve *Mercury* in *Nitric Acid* and dilute with *rain water.* Dip the article to be gilded in this solution and immerse afterwards in a weak solution of *Chloride of Gold.*

The philosophy of the action is as follows: The film of mercury, which is electro-positive to gold, dissolves in the chloride of gold solution, and a film of gold is electrolytically deposited in its place.

Dull Brass.—The German process to produce an artistic dull on brass is very easily obtained: Mix together 1 oz. of *Iron Oxide,* 1 oz. of *white arsenic,* 12 oz. of *Hydrochloric acid.* Apply with a brush after having cleaned the article thoroughly. Oil well, dry and lacquer.

Orange Gold Color on Brass.—Clean and polish the object and plunge it for less than a minute in a warm neutral solution of *Crystallized copper-acetate.* The brass should be heated previously to a degree just tolerable to the touch.

Bronzing Brass.—To bronze a brass article very quick and durably take a strong solution of *Nitrate of copper.* Boil the object in it. The shade to be attained varies with the length of boiling.

BRASS CLEANING PASTE.

The following makes a good cleaning paste: *Rotten Stone,* 6 oz.; *Oxalic Acid,* 1 oz.; equal parts of *Whale Oil* and *Spirits of Turpentine* sufficient to make a paste.

A general metal polishing paste may be made as follows, the quantity of the parts being by weight: *Petroleum Jelly* (white), 90 parts; *Kieselguhr,* 30 parts; *Refined Paraffine Wax,* 10 parts; *Refined Chalk* or *Whiting,* 10 parts; *Sodium Hypophosphite,* 8 parts. A little *Citronelle* can be added to cover up disagreeable odors and scent to paste.

A polishing powder may be made as follows, the quantities being by weight: *Putty Powder,* 14 parts; *Pipe Clay,* 14 parts; *Kieselguhr,* 42 parts; *Tartaric Acid* (powdered), 1½ parts.

BRASS POLISH.

This formula consists of the following: 16 lb. *Crude Oleic Acid,* 5 lb. *Kieselguhr,* 4 lb. *Tasteless Mineral Oil,* 1½ oz. *Lemon Oil.* Mix the powders into a paste and gradually thin with the mixed fluids, being careful to prevent formation of lumps. Apply with a rag or waste, and when practically dry rub with another rag or waste.

BRONZING COMPOSITIONS.

Silver White Bronzing Powder.—Melt together 1 oz. each, bismuth and tin, then add 1 oz. quickener, cool and powder.

Gold Colored Bronze Powder.—Verdigris, 8 ozs.; putty powder, 4 ozs.; borax and nitrate, of each 2 ozs.; bichloride of mercury, ½ oz.; make into a paste with oil and fuse them together. Used in japanning as a gold color.

Beautiful Red Bronze Powder.—Sulphate of copper, 100 parts; carbonate of soda, 60 parts; apply heat until they unite into a mass.

Antique Bronze Paint.—Sal ammoniac, 1 oz.; cream of tartar, 3 oz.; common salt, 6 ozs.; dissolve in 1 pt. hot water; then add nitrate of copper, 2 ozs.; dissolve in ½ pt. of water; mix well and apply it to the article in a damp place with a brush.

Blue Bronze on Copper.—Clean and polish well, then cover the surface with a fluid obtained by dissolving vermillion in a warm solution of sodium, to which some caustic potash has been added.

Bronze Dip.—Sal ammoniac, 1 oz.; salt of sorrel (binoxolate of potash), ¼ oz.; dissolved in vinegar.

Parisian Bronze Dip.—Sal ammoniac, ½ oz.; common salt, ½ oz.; spirits of hartshorn, 1 oz.; dissolved in an English qt. of vinegar. A good result will be obtained by adding ½ oz. sal ammoniac instead of spts. of hartshorn; the piece of metal when well cleaned is to be rubbed with one of these solutions, then dried by friction with a fresh brush.

Green Dip.—Wine vinegar, 2 qts.; verdigris, 2 ozs.; sal ammoniac, 1 oz.; salt, 2 ozs.; alum, ½ oz.; French berries, 8 ozs.; boil the ingredients together.

Aquafortis Dip.—Nitric acid, 8 ozs.; muriatic acid, 1 qt.; sal ammoniac, 2 ozs.; alum, 1 oz.; salt, 2 ozs.

Olive Bronze Dip for Brass.—Nitric acid, 3 ozs.; muriatic acid, 2 ozs.; add titanium or palladium, when the metal is dissolved add 2 gals. pure soft water to each pt. of the solution.

Brown Bronze Paint for Copper Vessels.—Tinct. of steel, 4 ozs.; spts. of nitre, 4 ozs.; blue vitriol, 1 oz.; water, ½ pt.; mix in a bottle, apply it with a fine brush, the vessel being full of boiling water. Varnish after the application of the bronze.

Bronze for All Kinds of Metal.—Muriate of ammonia (sal ammoniac), 3 drs.; oxalic acid, 1 dr.; vinegar, 1 pt.; dissolve the oxalic acid first; let the work be clean, put on the bronze with a brush, repeating the operation as many times as may be necessary.

Green Bronze.—Dissolve 2 ozs. nitrate of iron, and 2 ozs. hyposulphate of soda in 1 pt. of water; immerse the article until the required shade is obtained, as almost any shade from brown to red can be obtained according to the time of immersion, then wash well with water, dry and brush.

Pale Deep Olive Green Bronze.—Perchloride of iron, 1 part; water, 2 parts. Mix and immerse the brass.

Dark Green.—Saturate nitric acid with copper and immerse the brass.

Dead Black for Brass Work.—Rub the surface first with tripoli, then wash it with a solution of 1 part, neutral nitrate of tin, with 2 parts, chloride of gold, after 10 minutes wipe it off with a wet cloth.

Best Bronze for Brass.—Take 1 lb. of nitric acid, and ½ lb. of white arsenic, put them into an earthen vessel and then proceed in the usual manner.

Another Bronze for Brass.—1 oz. muriate of ammonia, ½ oz. alum, ¼ oz. arsenic, dissolve together in 1 pt. of strong vinegar.

Black Dip for Brass.—Hydrochloric acid (commonly called smoking salts), 12 lbs.; sulphate of iron, 1 lb.; and pure white arsenic, 1 lb. This dip is used in all the large factories in Birmingham, but the dip used in the London trade is 2 ozs. corrosive sublimate, in 1 pt. of the best vinegar, cork both in an air-tight bottle, let it stand 24 hours; then it is fit for use.

Quick Bright Dip for Brass.—Use strong nitric acid in sufficient quantity, dip your brass in the liquid for an instant, withdraw, and immediately immerse it first in cold water, and then in boiling water, for a short time only in each bath, then allow it to dry; repeat the process if necessary.

Application of Bronze Powder.—The proper way is to varnish the article and then dust the bronze powder over it after the varnish is partly dry.

Black Color for Brass Work.—Make a strong solution of nitrate of silver, and nitrate of copper separately. Mix the two together and plunge in the brass. Now heat the brass evenly till the required degree of blackness is acquired. Unrivalled as a beautiful color on optical instruments.

ORMOLU COLORING LACQUERS, ETC.

Ormolu coloring.—Alum, 30 parts; nitrate of potassa, 30 parts; red ochre, 30 parts; sulphate of zinc, 8 parts; common salt, 1 part; sulphate of iron, 1 part. It is applied with a soft brush. The articles are placed over a clear charcoal fire until the salts, melted and dried, assume a brown aspect. They are then suddenly cooled in nitric acid water, containing 3 per cent of hydrochloric acid, afterwards, washed in abundance of water and dried in sawdust.

To Prepare Brass Work for Ormolu Dipping.—If the work is oily, boil it in lye, and if it is finished work, filed or turned, dip it in old acid, and it is then ready to be ormolued, but if it is unfinished and

free from oil, pickle it in strong sulphuric acid, dip in pure nitric acid, and then in the old acid, after which it will be ready for ormoluing.

To Repair Old Nitric Acid Ormolu Dips.—If the work after dipping appears coarse and spotted, add vitriol till it answers the purpose; if the work after dipping appears too smooth, add muriatic acid and nitrate till it gives the right appearance. The other ormolu dips should be repaired according to the recipes, putting in the proper ingredients to strengthen them. They should not be allowed to settle, but should be stirred often while using.

Directions for Making Lacquer.—Mix the ingredients, and let the vessel containing them stand in the sun, or in a place slightly warmed, 3 or 4 days, shaking it frequently till gum is dissolved, after which let it settle from 24 to 48 hours, when the clear liquor may be poured off for use. Pulverized glass is sometimes used in making lacquer to carry down the impurities.

Lacquer for Dipped Brass.—Alcohol, (95 per cent) 2 gals.; seed lac, 1 lb.; gum copal, 1 oz.; English saffron, 1 oz.; annatto, 1 oz.

Lacquer for Bronzed Brass.—To 1 pt. of the above lacquer add gamboge, 1 oz., and, after mixing it, add an equal quantity of the first lacquer.

Deep Gold Colored Lacquer.—Best alcohol, 4 ozs.; Spanish annatto, 8 oz.; turmeric, 2 drs.; shellac, ½ oz.; red sanders, 12 grs.; when dissolved, add spts. of turpentine, 30 drops.

Deep Gold Colored Lacquer for Brass Not Dipped.—Alcohol, 4 gals.; turmeric, 3 lbs.; gamboge, 3 ozs.; gum sandarac, 7 lbs.; shellac, 1½ lbs.; turpentine varnish, 1 pt.

Gold Colored Lacquer for Dipped Brass.—Alcohol, 36 ozs.; amber, 2 ozs.; gum gutta, 2 ozs.; red sandal wood, 24 grs.; dragon's blood, 60 grs.; oriental saffron, 36 grs.; pulverized glass, 4 ozs.

Gold Lacquer for Brass.—Seed lac, 6 ozs.; amber or copal, 2 ozs.; best alcohol, 4 gals.; pulverized glass, 4 ozs.; dragon's blood, 40 grs.; extract of red sandal wood obtained by water, 30 grs.

LACQUER FOR DIPPED BRASS.

Alcohol, 12 gals; seed lac, 8 lbs.; turmeric, 1 lb. to a gal. of the above mixture; Spanish saffron, 4 ozs. The saffron is to be added for bronzed work.

GOOD LACQUER.

Alcohol, 8 ozs.; gamboge, 1 oz.; shellac, 3 ozs.; annatto, 1 oz.; solution of 3 ozs. of seed lac in 1 pt. alcohol. When dissolved, add ½ oz. Venice turpentine, ¼ oz. dragon's blood, will make it dark. Keep it in a warm place 4 or 5 days.

PALE LACQUER FOR TIN PLATE.

Best alcohol, 8 ozs.; turmeric, 4 drs.; hay saffron, 2 drs.; dragon's blood, 4 drs.; red sanders, 1 dr.; shellac, 1 oz.; gum sandarac, 2 drs.; gum mastic, 2 drs.; Canada balsam, 2 drs.; when dissolved, add spts. turpentine, 80 drops.

RED LACQUER FOR BRASS.

Alcohol, 8 gals.; dragon's blood, 4 lbs.; Spanish annatto, 12 lbs.; gum sandarac, 13 lbs.; turpentine, 1 gal.

PALE LACQUER FOR BRASS.

Alcohol, 2 gals.; cape aloes, cut small, 3 ozs.; pale shellac, 1 lb.; gamboge, 1 oz.

BEST LACQUER FOR BRASS.

Alcohol, 4 gals.; shellac, 2 lbs.; amber gum, 1 lb.; copal, 20 ozs.; seed lac, 3 lbs.; saffron to color; pulverized glass, 8 ozs.

COLOR FOR LACQUER.

Alcohol, 1 qt.; annatto, 4 ozs.

GILDER'S PICKLE.

Alum and common salt, each, 1 oz.; nitre, 2 ozs.; dissolved in water, ½ pt. Used to impart a rich yellow color to gold surfaces. It is best largely diluted with water.

QUICK BRONZING LIQUIDS.

For Immediate Action on Copper, Brass, or Zinc.—Brown or Dark Bronze for Copper, Brass or Zinc.—Dissolve 5 drachms nitrate of iron in 1 pt. of water; or, 5 drs. perchloride of iron in 1 pt. water. A black may also be obtained from 10 ozs. muriate of arsenic in 2 pts. permuriate of iron, and 1 pt. water.

Brown or Red Bronzing for Brass.—Dissolve 16 drs. nitrate of iron, and 16 drs. hyposulphate of soda, in 1 pt. water, or, 1 dr. nitric acid may be substituted for the nitrate of iron.

Red Brown Bronzing for Brass.—Dissolve 1 oz. nitrate of copper, and 1 oz. oxalic acid in 1 pt. water, brought to the boil and then cooled.

Dark Brown Bronzing for Brass.—Mix 1 oz. cyanide of potassium, and 4 drs. nitric acid, with 1 pt. water.

Red Bronzing for Brass.—Mix 30 grs. tersulphate of arsenic, 6 drs. solution of pearlash, and 1 pt. water.

Orange Bronzing on Brass.—Mix 1 dr. potash solution of sulphur with 1 pt. water.

Olive Green Bronze for Brass.—Dissolve 1 pt. permuriate of iron in 2 pts. water.

Slate-Colored Bronzing for Brass.—Dissolve 2 drs. sulphocyanide of potassium, and 5 drs. perchloride of iron, in 1 pt. water.

Steel Grey Bronzing for Brass.—Mix 1 oz. muriate of arsenic with 1 pt. water, and use at a heat not less than 180 degrees Fahr.

Bright Red Bronzing for Copper.—Mix 2 drs. sulphide of antimony and 1 oz. pearlash in 1 pt. water.

Dark Red Bronze for Copper.—Dissolve 1 dr. sulphur and 1 oz. pearlash in 1 pt. water.

Copper Colored Bronzing for Zinc.—Agitate the articles in a solution of 8 drs. sulphate of copper, and 8 drs. hyposulphate of soda in 1 pt. water.

BRONZING FLUID.

(For brown). Iron filings or scales, 1 pound, arsenic 2 ounces, hydrochloric acid, 1 pound; metallic zinc, 1 ounce. The article to be bronzed is dipped in this solution till the desired effect is produced.

BRONZING COPPER.

Castor oil, 20 parts; Alcohol, 80 parts; Soft soap, 40 parts; water, 40 parts. After copper has been scoured, cover with the above mixture until the desired color is obtained. Then dry in hot sawdust and coat with dilute varnish.

A GOOD SILVER POLISH.

Mix together one-half ounce of fine salt, one-half ounce of powdered alum and one-half ounce of common cream of tartar. Put them into a large porcelain pitcher and pour on two quarts of water and stir till entirely dissolved. Now transfer the mixture to clean bottles and cork tightly. Before using, shake well. Pour a little of the liquid out into a bowl and wash the silver all over with it, using an old linen cloth. Let it stand for 10 or 15 minutes, and rub off dry with a buckskin. The silver will look like new.

METAL POLISH.

A good metal polish may be made as follows: Take wood alcohol, 3 parts; aqua ammonia, 1 part; prepared chalk, ½ part. Apply the polish with a flannel and when dry wipe off. Shake the polish before using to get the chalk stirred up.

ALUMINUM POLISH.

An emulsion of equal parts of *Rum* and *Olive Oil* can be used for cleaning aluminum.

Potash Lye, not too strong, is also effective in brightening aluminum; *Benzol* is also used.

A good polish for aluminum consists of a paste formed of *Emery* and *Tallow,* the finish luster being obtained by the use of *Rouge Powder* with *Oil of Turpentine.*

ALUMINUM LACQUER.

For aluminum dissolve 100 parts *Gum Lac* in 300 parts *Ammonia,* heating for one hour over a *Water* bath, paint the thoroughly cleaned aluminum with the varnish and heat it to about 570 degrees Fahr.

COMPOSITION OF ALLOYS.

The number of alloy compositions such as bronze, brass and babbitts which are now placed on the market by various companies are almost innumerable, each containing various proportions, and some having special ingredients but nearly all contain practically the same combination as a basis. In almost every case the composition is varied slightly according to the uses to which the part cast from the alloy is to be put.

In general the composition of the most common alloys is as given in the accompanying table:

TABLE OF COMPOSITION OF COMMON ALLOYS

Alloys	Tin	Copper	Zinc	Antimony	Lead	Bismuth
Babbitt's metal	10	1	..	1	..	..
Bell-Metal	5	16	..	..	..	..
Brass, engine bearing	13	112	¼	..	..	..
Brass, locomotive bearings	7	64	1	..	..	..
Brass, for straps and glands	16	130	1	..	..	..
Flanges to stand brazing	..	32	1	..	1	..
Muntz's sheathing	..	6	4	..	..	..

COMPOSITION OF ALLOYS (CONT.)

Alloys	Tin	Copper	Zinc	Antimony	Lead	Bismuth
Metal to expand in cooling	..	..	..	2	9	1
Pewter	100	..	..	17	..	..
Spelter	..	1	1	..	..	..
Statuary Bronze	2	90	5	..	2	..
Tough brass, engine work	15	100	15	..	..	..
Tough brass, for heavy bearings	25	160	5	..	..	..
Yellow Brass, for turning	..	2	1	..	..	..
Solders						
For brazing (hardest)	..	3	1	..	..	..
For brazing (hard)	..	1	1	..	..	..
For brazing (soft)	1	4	3	..	..	..
For brazing (soft) or	2	..	..	1	..	..
For lead	1	..	..	..	1½	..
For pewter	2	..	..	..	1	..
For tin	1	..	..	..	2	..

A GOOD TEST FOR COPPER.

First take the solution supposed to contain copper and put it in a shallow vessel. When the solution is ready immerse a piece of iron or steel that has been cleaned of all rust. If the solution contains copper the iron or steel will be coated with metallic copper. Should copper not show in this test, pour in the solution a little ammonia; if copper is present a light blue precipitate will form and the solution will take on a blue color.

ALLOYS.

German Silver, First Quality Castings—Copper 50 lbs.; zinc 25 lbs.; Nickel 25 lbs.

German Silver for Rolling—Copper 50 lbs.; zinc 20 lbs.; nickel 25 lbs.

German Silver for Bells and other Castings—Copper 60 lbs.; zinc 20 lbs.; nickel 20 lbs.; lead 3 lbs.; iron, (that of tin plate is the best) 2 lbs.

Alfenide—Contains a trace of iron, copper 60 parts; zinc 30 parts; nickel 10 parts.

Fine Silver Colored Metal—Tin 100 lbs.; antimony 8 lbs.; copper 4 lbs.; bismuth 1 lb.

Genuine German Silver—Iron 2½ parts; nickel 31½ parts; zinc 25½ parts; copper 40 parts.

RELATIVE ELECTRICAL CONDUCTIVITY OF DIFFERENT METALS AND ALLOYS.

Metals	Relative Conductivity
Pure silver	100.
Pure copper	100.
Refined and crystallized copper	99.9
Telegraphic silicious bronze	98.
Alloy of copper and silver (50%)	86.65
Pure gold	78.
Silicide of copper, 4% Si	75.
Silicide of copper, 12% Si	54.7
Pure aluminum	54.2
Tin with 12% of sodium	46.9
Telephonic silicious bronze	35.
Copper with 10% of lead	30.
Pure zinc	29.9
Telephonic phosphor-bronze	29.
Silicious brass, 25% zinc	26.4
Brass with 35% zinc	21.59
Phosphor-tin	17.7
Alloy of gold and silver (50%)	16.12
Swedish iron	16.4
Pure Banca Tin	15.5
Antimonial copper	12.7
Aluminum bronze (10%)	12.6
Siemens steel	12.
Pure platinum	10.6
Copper with 10% of nickel	10.6
Cadmium Amalgam (15%)	10.2
Dronier mercurial bronze	10.14
Arsenical copper (10%)	9.1
Pure lead	8.88
Bronze with 20% of tin	8.4
Pure nickel	7.89
Phosphor-bronze, 10% tin	6.5
Phosphor copper, 9% phos.	4.9
Antimony	3.88

SUNDRY COMPOSITIONS.

Organ Pipe Metal—Consists of lead alloyed with about half its quantity of tin to harden it. Lead 100; tin 33 parts; or lead 100 and tin 20 parts answer very well. The mottled or crystalline appearance so much admired shows an abundance of tin.

Cannon Metal—Tin 10 parts; copper 90 parts.

Gong Metal—Copper, 78 parts; tin, 22 parts.

Alloy for Cymbals—Copper, 80 parts; tin, 20 parts.

Cock Metal—Copper 20 lbs.; lead 8 lbs.; litharge 1 oz.; antimony 3 ozs.

Metal for taking Impressions—Lead 3 lbs.; tin 2 lbs.; bismuth 5 lbs.

Electrum—Copper 8; nickel 4; zinc 3½ parts. This compound is unsurpassed for ease of workmanship and beauty of appearance.

Alloy, for Mechanical Instruments—Copper 1 lb.; tin 1 oz.

Fusible Metals—Melt together: 8 parts of *bismuth;* 3 parts of *tin;* 5 parts of *lead.* This mixture becomes liquid at 212 deg. Fahr.

Another—Melt together: 2 parts of *Cadmium;* 2 parts of *lead;* 4 parts of *tin.* Melting point 187 deg. Fahr.

AMALGAM RECIPES.

Tin and mercury combine readily at ordinary temperatures. If 3 parts mercury be brought into contact with 1 of tin 6-sided crystals of tin amalgam are formed. Tin amalgam is used for silvering looking glasses. When pulverized and rubbed on the polishing stone it forms a kind of mosaic silver. Electric amalgam may be made by melting tin and zinc together in various proportions in a porcelain crucible. The mixture is well stirred up, and when on the point of solidifying the mercury is added and worked into the mass. The whole is

next transferred to a mortar warm enough to keep the amalgam soft, while it is well worked together, after which a piece of tallow or lard, not quite equal in bulk to the mass, is kneaded in until the amalgam attains the proper consistency.

HOW TO MAKE ALLOYS.

For Clichés or Printing Plates.—Tin, 48 parts; lead, 32.5 parts; bismuth, 10.5 parts; antimony, 9 parts.

For Candlesticks, Spoons, Vessels.—Tin, 80 parts; lead, 20 parts.

For Imitation Silverware.—Tin, 92 parts; lead, 8 parts.

For Pieces of Jewelry; or Substitute for Silver.—Tin, 80 parts; antimony, 20 parts.

For Fusible Metal.—Bismuth, 50 parts; lead, 30 parts; tin, 20 parts.

Brass for Medals.—Copper, 95 parts; tin, 4 parts; zinc, 1 part.

Brass for Cymbals and Kettledrums.—Copper, 80 parts; tin, 20 parts.

Brass for Bells.—Copper, 77 parts; tin, 23 parts.

Substitute for Gold.—Copper, 94 parts; antimony, 6 parts; magnesium carbonat, 1/3 part.

IMITATION GOLD.

Take 16 parts of platina, 7 parts copper, 1 part zinc, put in covered crucible, with powdered charcoal and melt together till the whole forms one mass and all are thoroughly incorporated. Or take 4 oz. platina, 3 oz. silver and 1 oz. copper.

SUBSTITUTE FOR GOLD.

A substitute for gold is obtained by combining 94 parts of copper with 6 parts of antimony and adding a little magnesium carbonate to increase the weight. It is said that this alloy can be drawn, wrought and soldered very much like gold, and that it also takes and retains a gold polish. It is worth 25 cents a pound.

A GOOD SOLDERING SOLUTION.

Procure about 5 cents' worth of muriatic acid and add as much pure zinc as it will dissolve. If a little rain-water is added it will somewhat improve the mixture. The articles to be soldered should be thoroughly cleaned of every trace of dirt. The soldering solution is next applied with a wire brush to the cleaned surface. With this solution the solder will stick every time.

SOLDERS.

1. *Plumber's Solder.—Lead,* 2 parts; *Tin,* 1 part.

2. *Tinmen's Solder.—Lead,* 1 part; *Tin,* 1 part.

3. *Zinc Solder.—Tin,* 1 part; *Lead,* 1 to 2 parts.

4. *Spelter Solder.*—Equal parts *Copper* and *Zinc.*

5. *Glazier's Solder.—Tin,* 3 parts; *Lead,* 1 part.

6. *Solder for Copper.—Copper,* 10 parts; *Zinc,* 9 parts.

7. *Brass Solder.—Copper,* 61.25 parts; *Zinc,* 38.75 parts.

8. *Brass Solder, White.—Copper,* 57.41 parts; *Tin,* 14.60 parts; *Zinc,* 27.99 parts.

9. *Black Solder.—Copper,* 2 parts; *Zinc,* 3 parts; *Tin,* 2 parts.

10. *Cold Brazing Without Fire or Lamp.—Fluoric Acid,* 1 oz.; *Oxy-muriatic Acid,* 1 oz.; mix in a lead bottle. Put a chalk mark each side where you want to braze. This mixture will keep about six months in one bottle.

11. *To Solder Iron to Steel or Either to Brass.—Tin,* 3 parts; *Copper,* 39½ parts; *Zinc,* 7½ parts. When applied in a molten state it will firmly unite metals first named to each other.

12. *Plumbers' Solder.—Bismuth,* 1 part; *Lead,* 5 parts; *Tin,* 3 parts; is a first-class composition.

13. *Solder for Brass That Will Stand Hammering.—Brass,* 78.26 parts; *Zinc,* 17.41 parts; *Silver,* 4.33 parts; add a little chloride of potassium to your borax for a flux.

14. *Solder for Steel Joints.—Silver,* 19 parts; *Copper,* 1 part; *Brass,* 2 parts. Melt all together.

15. *Hard Solder.—Copper,* 2 parts; *Zinc,* 1 part. Melt together.

16. *Solder for Brass.—Copper,* 3 parts; *Zinc,* 1 part; with *Borax.*

17. *Solder for Copper.—Brass,* 6 parts; *Zinc,* 1 part; *Tin,* 1 part; melt all together well and pour out to cool.

18. *Solder for Iron.*—The best solder for iron is good tough brass with a little borax.

N. B.—In soldering, the surfaces to be joined are made perfectly clean and smooth, and then covered with sal-ammoniac, resin or other flux, the solder is then applied, being melted on and smoothed over by a tinned soldering iron.

Soldering Fluid.—Take 2 oz. *Muriatic Acid;* add *Zinc* till bubbles cease to rise; add ½ teaspoonful of *Sal-Ammoniac.*

COLD SOFT SOLDER.

Everyone at some time or other has had occasion to solder two pieces of metal, which because of their composition, or because of attached parts, could not be raised to the temperature that even soft solder flows at. The following solder meets that demand, as it can be used without heat.

Precipitate some copper from a copper solution, such as copper sulphate or copper nitrate by means of zinc or iron filings. Into a mortar pour some mercury and the copper precipitate. Add a few drops of dilute sulphuric acid and grind until the copper has united with the mercury. Wash the amalgam with water till bright and clean. Put into a cloth to dry and by means of a twisting motion, like grapes are strained, squeeze out the excess of mercury until the copper amalgam is just workable by the fingers. Rub well into the surfaces to be joined, and press together over night. Some of the mercury penetrates the surfaces, and some of the copper crystalizes out, and the compound becomes very hard. Strange to say, this compound is silver white. By using more mercury, a pliable metal is obtained that hardens slowly. If the solder is too hard, grind up with more mercury. Keep gold and silver jewelry, etc., out of the way, as mercury destroys them.

SOLDERING IRREGULAR PIECES.

To solder accurately irregular pieces of metal or the parts of a broken piece, press the parts into a lump of putty, placed on a piece of tinplate. Having thus formed a mould, remove and dry the putty with a gas jet. This burns the oil in the putty. When the mould is ready replace the pieces and also some solder in small pieces. Use a gas jet or blow-torch to heat same and do not remove the parts until quite cool.

"SOLDER" FOR METAL, GLASS AND PORCELAIN.

A soft alloy which adheres to metal, glass and porcelain and can be used in the same manner as soft solder is prepared from powdered copper (copper dust) which may be obtained by stirring a solution of blue vitriol with granulated tin. The solution becomes considerably heated and a fine brown powder is precipitated. Of this copper dust, 20 or 36 parts by weight, according to the desired hardness of the solder, are mixed in a cast-iron or a porcelain mortar with sulphuric acid of 1.85 specific gravity to the consistency of paste, and 70 parts of mercury added with constant stirring.

When the amalgam is thoroughly mixed it is carefully washed with water to remove all traces of acid, and then cooled off. In 10 or 12 hours the mass becomes very hard.

When the solder is to be used it should be heated to about 400 degrees Fahrenheit, in which condition it can be kneaded like wax in an iron mortar. In this plastic state it is applied to the broken surfaces, which are then pressed together, and when cooled the amalgam adheres very firmly.

SOLDERING FLUXES.

AN EXCELLENT SOLDERING FLUX.

This may be made by saturating a solution of zinc chloride in water and adding by weight one-tenth part of ammonium chloride. It is claimed that with this flux it is possible to solder enamel ware. This is impossible with most other fluxes.

A GOOD FLUX FOR SOLDERING TINFOIL.

This flux can be made by mixing sal-ammoniac (ammonium chloride) with vaseline and paraffine so as to form a paste. When soldering tinfoil it is advisable to lay the tinfoil on a sheet of copper, which conducts the heat away from the tinfoil. Otherwise the foil would be likely to melt.

SOLDERING WRINKLES.

Following are several hints on solders and soldering fluxes. A Valuable Soldering Liquid: Cut zinc into small pieces, dissolve in hydrochloric acid, add one-fourth part of the solution of ammonia and dilute with water. Dissolve in twelve parts of water one and one-half parts of glycerine and one and one-half parts lactic acid.

Soldering Paste: Make a syrup of starch paste with a solution of chloride of tin.

Fluxes for Welding: A secret well worth knowing is as follows: Take 6 ounces of common salt, 1 ounce of black oxide of manganese, 2 ounces of copperas, 1 ounce of saltpeter, 1 ounce of prussiate of potash; pulverize and mix with 3 pounds of welding sand.

Solders—How They Are Made. Soft spelter is made of 1 part copper, 1 part zinc.

Hard spelter, 2 parts copper, 1 of zinc; plumbers' coarse solder, 1 part tin, 3 lead; plumbers' seal solder tin 1, lead 2; tinners' solder, tin 1½, lead 1; hard solder for copper; brass and iron, copper 2, zinc 1; silver solder for jewelers, silver 19, copper 1, brass 1; silver solder for plating, silver 2, brass 1; silver for silver brass and iron, silver 1, brass 1; gold solder, gold 12, silver 2, copper 4; bismuth solder, lead 4, tin 4, bismuth 1.

HOW TO SOLDER ALUMINUM.

There are various compounds on the market for soldering aluminum, but this operation depends more on the workman than on the solder and unless considerable experience has been had it is probably better to purchase solder than to attempt making it. Zinc can be used but does not form a very strong joint. Tin can also be used, is more nearly the color of aluminum, is stronger than zinc, but is very difficult to work. A small proportion of phosphor tin added to pure tin makes it work more readily and is the basis of most aluminum solder.

The chief difficulty in soldering aluminum is that the heat is dissipated so rapidly that it cools the soldering iron and furthermore aluminum oxidizes instantly upon exposure to the air. This extremely thin film effectually prevents a perfect union being made. If the parts are well heated and melted solder kept hot while the iron is allowed to stand on it, the surface can be scraped beneath the melted solder by the point of the soldering iron, thus preventing to a certain extent the oxidization. In this way the metal can be tinned. When both parts to be brought together are well tinned, the parts can be united with some chance of success, nitrat of silver, resin, or zinc chlorid being used as a flux. A soldering tool of nickel gives more satisfactory results than a copper one as the latter alloys with the tin and soon becomes rough.

Cleaning the Metal: If the surface is of such a shape that it cannot be readily cleaned by scraping, it can be cleaned by dipping it into a solution of nitric acid in three times its bulk of hot water containing about 5 per cent of commercial hydrofluoric acid. This causes a slight action on the surface of the metal as shown by bubbles. Rinse the metal after removing from the acid bath and dry in hot sawdust.

ALUMINUM SOLDER.

The following formula, in the hands of a competent man, can be used to unite aluminum or aluminoid parts:

Tin—10 parts.

Cadmium—10 parts.

Zinc—10 parts.

Lead—1 part.

These parts to be united must be thoroughly cleansed and allowed to stand two to three hours in a strong solution of Hypo-Sulphate of soda before being operated upon, or cleaned in the acid bath described above.

SOLDER FOR ALUMINUM.

Consists of zinc, tin, aluminum phosphorus. The first two containing the bulk of the alloy. This solder can be used either with the blow pipe or the iron. If the former is used a little silver can be added to it without making it melt and giving it a better color. The surfaces to be soldered are first scraped clean then tinned with the solder itself, no flux being needed. Silver, 2%; Aluminum Phosphorus, 9%; Tin, 34%; Zinc, 50%.

WELDING.

Welding Composition. — Dissolve in water 30 parts of *Borax,* 4 parts of *Sal Ammoniac,* 4 parts of *Cyanide of Potash.* Evaporate the water at a low temperature.

Welding Flux.—Pulverize the following ingredients: 2 oz. of *Copperas,* 1 oz. of *Saltpeter,* 6 oz. of *Salt,* 1 oz. of *Oxide of Manganese,* 1 oz. of *Cyanide of Potash.* Mix together with 3 lbs. of good *Welding Sand.*

Welding Powders.—Calcine and pulverize together 50 parts of *Iron Filings,* 5 parts of *Sal Ammoniac,* 3 parts of *Borax,* 2½ parts of *Copaiba Balsam.*

To Weld Cast Iron.—Take of good, clear *White Sand,* 3 parts; *Refined Solton,* 1 part; *Fosterine,* 1 part; *Rock Salt,* 1 part; mix all together. Take the two pieces of cast iron, heat them in a moderate charcoal fire, occasionally taking them out while heating and dipping them into the composition until they are of a proper heat to weld, then at once lay them on the anvil and gently hammer them together.

To Weld Cast Iron.—The best way of welding cast iron is to take it at a very intense heat, closely approaching the melting point. In this state it will be found sufficiently malleable to stand welding by the hammer.

Composition Used to Weld Cast Steel.—10 parts *Borax,* 1 part *Sal Ammoniac.* Grind or pound them thoroughly together, then fuse them in a metal pot over a clear fire, taking care to continue the heat until all spume has disappeared from the surface. When the liquid appears clear the composition is ready to be poured out to cool and concrete; afterward being ground to a fine powder, it is ready for use. To use this composition the steel to be welded is raised to a heat which may be expressed as "bright yellow." It is then dipped among the welding powder and again placed in the fire until it attains the same degree of heat as before. It is then ready to be placed under the hammer.

Composition for Welding Cast Steel.—Pulverize borax, any quantity, and slightly color it with dragon's blood. Heat the steel red hot, shake the borax over it; place it again in the fire till the borax smokes on the steel, which will be much below the ordinary welding heat, and then hammer it.

German Welding Powder.—4 parts *Iron Turnings,* 3 parts *Borax,* 2 parts *Borate of Iron,* 1 part *Water.*

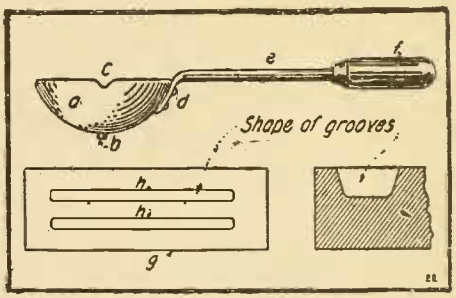
Welding a Small Piece of Iron Upon a Large One, with Only a Light Heat.—It is often desirable to weld a small bit of iron upon a large bar, when the large piece must be heated equally hot as the small one. To save this take *Borax,* 1 lb., *Red Oxide of Iron,* 1 to 2 oz. Melt them together in a crucible, and when cold pulverize it and keep the powder dry for use. When you want to perform the operation, just bring the large piece to a white heat, having a good welding heat upon the small slip; take the large one from the fire and sprinkle some of the powder upon the place, and bring the other upon it, applying the hammer smartly, and the weld will be as good as could be made with the greater heat without the powder.

BELGIAN WELDING POWDER.

1,000 parts *Iron Filings,* 500 parts *Borax,* 50 parts *Balsam of Copaiba or other resinous oil,* 75 parts *Sal Ammoniac.* Mix all well together, heat and pulverize completely. The surfaces to be welded are powdered with the composition and then brought to a cherry-red heat, at which the powder melts, when the portions to be united are taken from the fire and joined. If the pieces to be welded are too large to be introduced into the forge, one can be first heated with the welding powder to a cherry-red heat and the other afterward to a white heat, after which the welding may be effected.

CASTING BARS OF SOLDER.

In the drawing herewith (a) is a gong from an electric bell with a dent (c) bent in one side of it with a pair of pincers; (b) is a rivet passed through the hole in the gong, while (e) is an iron rod riveted to (a) at (d). A pea shooter makes an admirable substitute for the iron rod. Here (f) is a wooden handle. (g) a block of hard wood in which grooves (hh) are made. The solder is poured from the ladle into



Simple Outfit for Casting Your Own Bars of Solder. A Handy Ladle Is Made from a Bell Gong Fitted with a Handle.

these grooves. Sandpaper the grooves well and the solder can be easily removed.

RUST REMOVER.

Powdered Alum in strong *Vinegar, Oil of Tartar* or fine *Emery* are often used to remove rust. *Kerosene* or *Turpentine,* if left on the stained or rusted portions over night, will sufficiently soften the rust so that it may be removed by the use of fine emery cloth followed by a polishing powder.

TO CLEAN BRASSWARE.

Mix one ounce of oxalic acid, six ounces of rotten stone in a powder, one ounce of sweet oil and enough water to make a paste. Apply a small amount and rub dry with a flannel. This is a lot better than most of the polishes, as it will not corrode the brass as do polishes that contain nitric or other acids.

TO CLEAN BRASS.

Rub it with a mixture of *Vinegar* and *Salt,* or *Oxalic Acid,* then wash with *Water* and polish with *Tripoli* and *Sweet Oil.*

Another liquid polish for metal is as follows: *Jewelers' Red,* 25 parts; *Oil of Turpentine,* 15 parts; *Oil of Stearine,* 25 parts; *Animal Charcoal,* 45 parts; *Alcohol* sufficient to make the mass practically liquid. Apply with a brush. After the alcohol has evaporated rub with a cloth.

TRANSPARENT FOR TOOLS.

Best alcohol, 1 gal.; gum sandarac, 2 pounds; gum mastic, ½ pound. Place all in a tin can which admits of being corked; cork it tight, and shake it frequently, occasionally placing the can in hot water. When dissolved it is ready for use. This makes a very nice varnish for new tools which are exposed to dampness, etc.

RUST SPOTS ON NICKEL.

Rust spots on nickel can be treated with *Grease,* and after several days rubbed with a rag saturated with a few drops of *Hydrochloric Acid* in *Ammonia.* Parts should be thoroughly rinsed, dried and polished.

RUST PREVENTIVE.

The following is a good rust preventive for steel; 16 parts *Turpentine* and 1 part *Caoutchouc* dissolved by a gentle heat. To this add 8 parts *Boiled Oil,* stir and at the same time bring to the boiling point. Apply with a brush after the manner of varnishing. This coating can be removed by the use of *Turpentine* if desired.

ETCHING FOR METALS.

(1) *Brass Signs*—Paint sign with asphalt varnish, leaving the parts to be etched unpainted. Raise a border around the outside, made of soft Beeswax. Take 1 part of *Nitric Acid* diluted in 5 parts of *Water.* Pour this solution on to the sign about ¼ inch deep. When the letters are etched deep enough, pour acid off, clean plate by heating and wiping with turpentine.

(2) *Copper Etching.*—1 part of *Nitric* or *Sulphuric Acid;* 2 parts of *Potassium Bichromate* (Saturated solution); 5 parts of *Water.*

(3) *Etching on Cutlery*—Take 1 part of *Asphaltum;* 1 part of *Burgundy Pitch;* 1 part of *Beeswax.* Melt together and mix. Warm the piece of cutlery, take a ball of cotton and smear a small quantity of the above wax on the blade, evenly all over the surface. When cold, scratch the required design or name on the article and touch the parts with a solution of one part of *Nitric Acid* in five parts of *Water,* using a camel's hair brush.

After a few minutes dip in hot water and wipe the blade with benzine.

(4) *Etching on Glass*—Mix together in a receptacle of lead: 3 parts of *Sulphate of Barium;* 1 part of *Fluoride of Ammonium* with *Sulphuric Acid* sufficient to bring the mixture to the consistency of rich milk. Cover the glass with a small quantity of hot beeswax. To etch proceed as for cutlery.

(5) *Etching on Silver*—Same as copper or brass.

(6) *Etching on Bronze*—100 parts of pure *Nitric Acid* at 40°; 5 parts of *Muriatic Acid* at 20°.

(7) *Etching on Brass*—Take 60 parts of *Nitric Acid* at 40°; 160 parts of *Water.* Dissolve 6 parts of *Potassium Chlorate* in 100 parts of *Water.* Mix the two solutions together.

(8) *Etching on Steel*—62 parts of *Nitric Acid;* 125 parts of *Water;* 187 parts of *Alcohol;* 8 parts of *Copper Nitrate.*

(9) *Zincographic Etching*—2 parts of *Sulphate of Copper;* 3 parts of *Chloride of Copper;* 64 parts of *Water;* 8 parts of *Muriatic Acid.*

(10) *Different Grounds for Etching*—(*a*) 30 parts *White Wax;* 30 parts *Gum Mastic;* 15 parts Asphaltum. (*b*)3 parts *White Wax;* 1 part *Block Pitch;* 4 parts *Asphaltum;* 1 part *Rosin.* (*c*) 4 oz. soft *Linseed Oil;* ½ oz. *Gum Benzoin;* ½ oz. *White Wax.* Boil together.

ETCHING ON STEEL.

Cover the article with a film of paraffin wax (or candle grease) and with a scriber write or mark on the surface whatever is required, making sure to cut clean through the wax. Sprinkle some salt over this and then cover with strong nitric acid. The etching should be continued for an hour or so, depending upon the depth of the etched part. Then clean off with hot water and grease the article to prevent any rusting.

HOW TO FILE SOFT METALS.

The teeth of a file are soon filled when the file is used on lead, tin, soft solder or aluminum. It cannot be cleaned like the wood rasp by dipping it into hot water, but if the file and the work are kept wet with water, there will be no trouble as the already wet particles of lead, soft solder, etc., do not readily adhere to the file.

TO PREVENT LEAD EXPLODING.

Many mechanics have had their patience sorely tried when pouring melted lead around a damp or wet joint to find it explode, blow out, or scatter from the effects of steam generated by the heat of the lead. The whole trouble may be stopped by putting a piece of resin the size of the end of a man's thumb into the ladle and allowing it to melt before pouring.

HOW TO CUT BRASS.

With a quill pen dipped in a strong solution of alcoholic corrosive sublimate (*careful; strong poison*) draw a line on the brass. After letting this dry, go over the line with the pen dipped in nitric acid. Then the metal may be broken as glass is cut with a diamond.

TO BORE A HOLE IN HARDENED STEEL.

Melt a small quantity of wax and pour it on to the steel. Make a hole in the wax of the dimensions desired.

Then put a few drops of nitric acid in the hole and leave it for some time. If not eaten through in 15 or 20 minutes wash the acid off and apply another dose. Continue this until the hole is eaten through.

Non-rusting soldering fluid:—While the zinc chloride soldering flux works nicely on steel, so far as soldering goes, it should not be used where there is danger of rust. A solution that will not cause rust, is made by mixing

6 oz. alcohol
2 oz. glycerine
1 oz. oxide of zinc

HOW TO PREPARE PURE SILVER FROM COIN SILVER.

Silver coins are not pure silver, but contain copper to make them harder. Canadian silver coins contain 925 parts of silver and 75 parts of copper to each 1,000 parts, and the metal is called Sterling Silver. United States silver coins contain 900 parts silver and 100 parts copper to each 1,000 parts, and the metal is called "900 fine."

In order to prepare the pure silver and to get rid of the copper, a silver coin is dissolved in dilute nitric acid (HNO_3). The solution is then diluted with hot water to 200 or 300 cubic centimeters (approximately 7 or 10 ounces).

To this add a solution (hot) of sodium chlorid (common salt) which will throw down an insoluble precipitate of silver chlorid. Wash the precipitat thoroughly by decantation; that is, by successively pouring on hot water and allowing the precipitat to settle, then pouring off the clear liquid. After a thorough washing in this manner, filter the solution through filter paper and dry it carefully in warm air. Remove the precipitat from the filter paper and place it in a porcelain crucible. Heat gently with a small flame until the silver chlorid is melted then let it cool.

Cut out a piece of sheet zinc large enough to cover the bottom of the crucible and lay it on the silver chlorid. Now add a little water and a few drops of dilute sulphuric acid (H_2SO_4) and let the whole stand for twenty-four hours. The silver chlorid will be reduced to silver and zinc chlorid is formed. Take out the piece of zinc and wash the silver with a little dilute sulphuric acid and then with water. This finely divided silver may be fused in a crucible by drying it and mixing with half its weight of sodium carbonat and apply sufficient heat.

SHOP KINKS.

In drilling wrought iron or steel, always use plenty of oil. Lard oil is commonly used for such work. The oil helps to carry away the heat. When drilling or boring in cast iron, no oil is necessary. Light drilling in brass requires no oil, but fairly heavy drilling should have oil. Copper is one of the toughest materials and should receive plenty of oil. To drill large holes accurately, use a small drill first.

SHOP KINKS.

Lay dull files in diluted sulphuric acid until they are eaten deep enough.

Chasing Threads in Aluminum: When cutting threads on aluminum use a little oil with coal oil, about (1) one teaspoon of oil to (1) one pint of coal oil, and the threads will not clog up, but will take a fine finish as if cut in steel.

A GOOD SILVER WASH.

Take 1 ounce of pure nitric acid, 1 silver dime (or, better, a Canadian five-cent piece, which is also silver) and 1 ounce of quicksilver. These ingredients are now placed in a glass vessel and left until they are completely dissolved. Then add a pint of water and next enough powdered whiting to make the whole into a powder. This silver wash may be used on brass, copper, German silver, etc.

TO PROTECT POLISHED STEEL OR IRON FROM RUST.

Go over the surface with paraffin, or steep the iron for a few moments in a solution of soda acidulated with muriatic acid. The result is a blue-black coating, not affected by air or water.

HOW TO PREVENT PEN POINTS FROM GETTING RUSTY.

To prevent pens from becoming rusty place a few old pen points (or some pieces of iron wire) in your ink supply. The pens eat up the acid in the ink and thereby keep your pen free from the acid.

MARKING TOOLS WITH ACID.

We recommend the following etching fluid for marking tools: Mix one part of muriatic acid, one of nitric and four parts of water. The tool is coated with wax and the design is then scratched in.

Perfumery, Soaps and Extracts.

PERFUMERY.

In all the following formulas secure the best ingredients regardless of price. Quality is of the first importance. Procure the best spirits of deodorized alcohol obtainable. When the perfumes are mixed they should be frequently agitated and allowed to stand two or three weeks before filtering. *Age improves all perfumes,* if kept in a moderate atmosphere and in a dark place.

French Jockey Club Bouquet.—Esprit de Rose, 1 pt.; Esprit de Tuberose, 1 pt.; Esprit de Cassie, ½ pt.; Esprit de Jasmine, ¾ pt.; Extract Civet, 3 oz.

The Guard's Bouquet.—Esprit de Rose, 2 pts.; Esprit de Neroli, ½ pt.; Extract Vanilla, ½ pt.; Extract Orris, ½ pt.; Extract Musk, ¼ pt.; Otto of Cloves, ½ dr.

Yacht Club Bouquet.—Extract of Santal, 1 pt.; Extract of Neroli, 1 pt.; Extract of Jasmine, ½ pt.; Extract Triple Rose, ½ pt.; Extract Vanilla, ¼ pt.; Flowers of Benzoin, ¼ oz.

Japanese Perfume.—Extract of Triple Rose, ½ pt.; Extract of Vitivert, ½ pt.; Extract of Patchouly, ½ pt.; Extract of Cedar, ½ pt.; Extract of Santal, ½ pt.; Extract of Verveine, ¼ pt.

Lavender Extract.—Oil of Lavender (English Mitcham), 4 drs.; Essence of Rose, 2 oz.; Best Alcohol, 14 oz.

Lily of the Valley.—Essence of Tuberose, 8 oz.; Essence of Jasmine, 1 oz.; Essence of Orange Flowers, 1 oz.; Essence of Cassie, 2 oz.; Essence of Rose, 2 oz.; Spirit of Rose, 1 oz.; Tincture of Vanilla, 1 oz.; Oil of Bitter Almonds, 2 drops.

New Mown Hay.—Tincture of Tontka, 4 oz.; Tincture of Musk, 1 oz.; Tincture of Benzoin, 1 oz.; Spirit of Rose, 1 oz.; Oil of Rose Geranium, 40 min.; Oil of Bergamot, 40 min.; Rectified Alcohol, 1 oz.

Moss Rose.—Spirit of Rose, 9 oz.; Essence of Orange Flowers, 3 oz.; Essence of Rose, 2 oz.; Tincture of Civet, 1 oz.; Tincture of Musk, 1 oz.

White Rose.—Oil of Turkish Geranium, 2 oz.; Oil of Bergamot, 2 oz.; Extract of Benzoin, 2 oz.; Extract of Vanilla, 2 oz.; Alcohol, 2 gals.; Water, 2 pts.

Violet Extract.—Essence of Violet, 4 oz.; Essence of Cassie, 1 oz.; Essence of Rose, 3 drs.; Tincture of Orris, 1 oz.; Tincture of Ambergris, 2 drs.; Tincture of Civet, 2 drs.; Spirit of Almond, 20 min.

Ylang-Ylang.—Spirit of Ylang, 8 oz.; Spirit of Rose, 4 oz.; Essence of Jasmine, 2 oz.; Tincture of Civet, 2 oz.

SOAPS.

Transparent Soap.—Slice 6 lbs. nice *Yellow Bar Soap* into shavings; put into a brass tin or copper kettle, with *Alcohol,* ½ gal., heating gradually over a slow fire, stirring till all is dissolved; then add 1 oz. *Sassafras Essence* and stir until all is mixed; now pour into pans about 1½ inches deep, and when cold cut into square bars the length or width of the pan as desired.

English Bar Soap.—Six gal. *Soft Water,* 6 lb. good *Stone Lime,* 20 lb. *Sal-Soda,* 4 oz. *Borax,* 15 lb. *Fat* (*Tallow* is best), 10 lb. *Pulverized Resin* and 4 oz. *Beeswax;* put the water in a kettle on the fire, and when nearly boiling add the lime and soda; when these are dissolved, add the borax. Boil gently, and stir until all is dissolved; then add the fat, resin and beeswax.

Best Soft Soap.—Mix 10 lb. *Potash* in 10 gal. *Warm Soft Water* over night; in the morning boil it, adding 6 lb. *Grease;* then put all in a barrel, adding 15 gal. *Soft Water.*

German Yellow Soap.—*Tallow* and *Sal-Soda,* of each 112 lb.; *Resin,* 56 lb.; *Stone Lime,* 28 lb.; *Palm Oil,* 8 oz.; *Soft Water,* 28 gal. Put soda, lime and water into a kettle and boil, stirring well; then let it settle, and pour off the lye. In another kettle melt the tallow, resin and palm oil; having it hot, the lye being also boiling hot, mix all together, stirring well, and the work is done.

German Yellow Soap.—Small quantities.—Tallow and Sal-Soda, each 1 lb.; *Resin,* 7 oz.; *Stone Lime,* 4 oz.; *Palm Oil,* 1 oz.; *Soft Water,* 1 qt.

Hard Soap with Lard.—Sal-Soda and *Lard,* each 6 lb.; *Stone Lime,* 3 lb.; *Soft Water,* 4 gal.; dissolve the lime and soda in the water by boiling, stirring, settling and pouring off; then return to the kettle (brass or copper) and add the lard, and boil it till it becomes soap; then pour into a dish or moulds; and, when cold, cut into bars and dry it.

Camphor Soap.—Curd Soap, 28 lb.; *Otto of Rosemary* 1¼ lb. Reduce the *Camphor* to powder, add 1 oz. *Almond Oil,* then sift it; when the soap is melted and ready to turn out, add the camphor and rosemary.

Sand Soap.—Curd Soap, 7 lb.; *Marine Soap,* 7 lb.; *Sifted Silver Sand,* 28 lb.; *Oils Thyme, Cassia, Caraway* and *French Lavender,* of each 2 oz.

Shaving Paste.—4 oz. of *Naples Soap,* 2 oz. of *Powdered Castile Soap,* 1 oz. of *Honey,* 5 drops each of *Essence of Ambergris, Oil of Cassia, Oil of Nutmegs.* Melt the soap in water bath, add honey and when nearly cool add the oils and essence.

CARPET SOAP.

Carpet soap can be made as follows: Three small bars of good white soap, 2 gallons of water, 1 10-cent bottle of household ammonia, ½ box of borax and 10 cents worth of tartar. Dissolve the soap in water on top of stove; then add other ingredients. Let boil 10 minutes and then remove from the stove.

SALVES AND LINIMENTS.

Court Plaster.—Brush silk over with a solution of isinglass, in spirits or warm water, dry and repeat several times. For the last application apply several coats of balsam of Peru. Used to close cuts or wounds, by warming it and applying. It does not wash off until the skin partially heals.

Artificial Skin.—For Burns, Bruises, Abrasions, etc. Proof against Water.—Take gun cotton and Venice turpentine, equal parts of each, and dissolve them in 20 times as much sulphuric ether, dissolving the cotton first, then adding the turpentine; keep it corked tightly.

The object of the turpentine is to prevent pressure or pinching caused by evaporation of the ether when applied to a bruised surface. Water does not affect it, hence its value for chapped hands, surface bruises, etc.

Adhesive Plaster, or Salve, for Deep Wounds, Cuts, etc., in Place of Stitches.—White Rosin, 7 ozs.; bees wax and mutton tallow, of each ½ oz.; melt all together, then pour into cold water and work as wax until thoroughly mixed, then roll out into suitable sticks for use.

It may be spread upon firm cloth and cut into narrow strips. In case of deep wounds, or cuts, it will be found to firmly hold them together, by first pressing one end of a strip upon one side of the wound until it adheres, then draw the edges of the wound closely together, and press down the other end of the strip until it adheres also. The strips should reach three or four inches upon each side of the cut, and run in different directions across each other, to draw every part of the wound firmly in contact. It will crack easily after being spread until applied to the warm flesh, yet if made any softer it cannot be depended upon for any length of time, but as it is, it has been worn as a strengthening plaster, and remained in place over a year.

Burns.—Salve for Burns.—Equal parts of turpentine, sweet oil, and beeswax; melt the oil and wax together.

When a little cool, add the turpentine, and stir until cold, which keeps them evenly mixed. Apply by spreading upon thin cloth—linen is the best.

It is good for chaps on hands or lips, or for any other sore. If put on burns before blistering has taken place, they will not blister.

Chilblains.—To Cure.—Mutton tallow and lard, of each ¾ lb.; melt in an iron vessel and add hydrated oxide of iron, 2 oz.; stirring continually with an iron spoon, until the mass is of an uniform black color; then let it cool and add Venice-turpentine, 2 oz.; and Armenian bole, 1 oz.; oil of bergamot, 1 dr.; rub up the bole with a little olive oil, before putting in. Apply several times daily by putting it upon lint or linen—heals the worst cases in a few days.

(Chilblains arise from a severe cold to the part, causing inflammation, often ulcerating, making deep, and very troublesome, long continued sores.)

Warts and Corns.—To Cure in Ten Minutes.—Take a small piece of potash and let it stand in the open air until it slacks, then thicken it to a paste with pulverized gum arabic, which prevents it from spreading where it is not wanted.

Pare off the seeds of the wart or the dead skin of the corn and apply the paste, and let it remain on ten minutes; wash off, and soak the place in sharp vinegar or sweet oil, either of which will neutralize the alkali. Now do not jam nor squeeze out the wart or corn, like "street-corner peddlers," but leave them alone, and nature will remove them without danger of taking cold, as would be if a sore is made by pinching them out. Corns are caused by pressure; in most cases removing the pressure cures the corn. Nine of every ten corns can be cured by using twice daily, upon it, any good liniment, and wearing loose shoes or boots.

Shaking Liniment.—Turpentine and senca oils, of each 7 1/3 ozs.; sweet oil and tincture of arnica, of each 3 2/3 ozs.; oils of organum, hemlock, juniper, amber, and laudanum, of each 1 1/3 ozs.; spirits of ammonia, ½ oz.; and gum camphor, ¼ oz.; which makes a little less than 1 qt.

FORMULA FOR DISINFECTANT.

1 *oz.* 6 *drams Guaiacol*
1 *oz.* 3 *drams Eucalyptol*
6 *drams Menthol*
1 *oz.* *Carbolic Acid*
3 *drams Thymol*
½ *dram Oil Clove*
Enough Alcohol to make 2 lbs.
To be sprayed about with water.

EXTRACTS.

Cocoa.—Dissolve 1 lb. of *Chocolate* in 1 qt. of *Boiling Water,* let it cool, take out the *Cocoa Butter* and add to it 4 oz. of *Glycerine* and bottle.

Compound Coffee (for Dispensing).—8 oz. best (ground) *Java Coffee;* 2 drm. sliced *Vanilla Bean;* add diluted *Alcohol* in sufficient quantity.

Plain Coffee Extract.—Pour upon 1 lb. of best fresh roasted *Coffee* 1 qt. of *Cold Water,* heat gently for half an hour then let it come to a boil, cool for 2 hours, strain and add 4 oz. of *Glycerine.*

Ginger (for dispensing).—Take 1½ pt. of *Fluid Extract of Ginger,* 3 pts. of *Water,* 3 oz. of *Carbonate of Magnesia;* mix, shake often for 24 hours; filter, evaporate to ¾ pt. and add ¾ pt. of *Alcohol.*

Mead.—Oil of Lemon, 1 oz.; *Oil of Cloves,* 2 drm.; *Oil of Cinnamon,* 2 drm.; *Oil of Nutmeg,* 1 drm.; *Oil of Allspice,* 30 drops; *Oil of Sassafras,* 40 drops; *Oil of Ginger,* 1 drm.

Cut the *Oils* with *Pumice* and *Sugar;* dissolve in 16 or 32 oz. of *Alcohol.*

Add gradually an equal quantity of *Water;* clarify.

Liebig's Meat Extract.—1 oz. *Lean Meat,* very fresh, chopped very small; add 8 oz. *Cold Water;* shake well together for 10 minutes; heat gradually to boiling, let simmer gently for a few minutes, strain through a hair sieve while still hot; evaporate to a soft substance.

Sarsaparilla Extract.—Take 16 oz. *Jamaica Sarsaparilla,* cut transversely, 280 oz. *Distilled Water* (160° F.) macerate in half the water for 6 hours and decant the liquor. Digest the residue in the remainder of the water for six hours more, mix the liquors, press and filter.

Evaporate by a water bath to 7 oz. when cold, add 1 oz. of *Rectified Spirit.*

Peach.—3 drm. Oil of Almonds, 3 drm. Oil of Pineapple, 3 drm. Tartaric Acid, 1½ pt. of Alcohol, 80°

Pineapple.—2 oz. of Pineapple Essence, 1 oz. of Citric Acid, 2 pts. of Alcohol, 80°.

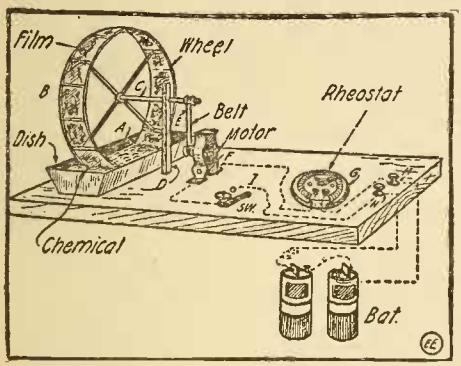
Strawberry.—1½ oz. of Pineapple Oil, ¾ oz. of Tincture of Orris, ¾ oz. of Tartaric Acid, 1½ pts. of Alcohol, 80°.

Photography.

AN ELECTRIC FILM DEVELOPER.

Many of us enjoy taking pictures but there are few who can afford a film tank, and we have to develop by hand in a *stuffy* dark room. To obviate this difficulty the following instrument was developed. All the materials can be obtained around the house and can be put together in a few minutes.

First the wheel B is assembled on rod C, which rotates through a hole in rod D. The rod C is turned by belt E (a rubber band can be used) which is made to rotate by a small battery motor F. Care must be taken that the motor does not run too fast while you are developing a film. To overcome this trouble a rheostat G is



Useful Scheme Employing Battery Motor for Moving Photographic Film Thru Developing Bath.

put in the battery circuit. The starting switch I, binding-posts H and one or two batteries complete the outfit.

It is clear how the film drum is made. When the dish A is removed the wheel B can be revolved at high speed. This will dry the film very quickly. This device is also good for amateur motion picture developing.

PHOTOGRAPHIC BATHS.

(DEVELOPERS).

Eikonogen Developers.—No. 1. 20 oz. *Distilled Water,* 2 oz. of *Sulphite of Soda* (cryst.), ½ oz. of *Eikonogen Crystal.*

No. 2. 20 oz. *Distilled water,* ¾ oz. *Carbonate of Potash.* Mix No. 1 and 2 in equal parts, and to each ounce add 2 to 4 drops 10 per cent solution *Bromide of Sodium.*

Hydrochinon Developer.—No. 1. 10 oz. of *Distilled Water,* 2 oz. of *Sulphite of Sodium* in cryst. chem. pure, 1 oz. of *Hydrochinon.* Dissolve and keep in a yellow bottle. No. 2. 10 oz. of *Distilled Water,* 2 oz. of *Carbonate of Potash,* 1 oz. of *Carbonate of Soda.* Mix 2 drm. of No. 1 and 1½ drm. of No. 2, then add 3 oz. of *Water* (dist.).

Combined Hydrochinon and Eikonogen Developers.—No. 1. 60 parts of *Sulphite of soda* (cryst.), 40 parts of *Crystal Soda,* 1,000 parts of *Distilled Water.* After solution filter. No. 2. 50 parts of *Eikonogen,* 50 parts of *Hydrochinon.* Place together in a mortar, grind down to fine powder and keep dry in well stoppered glass bottle. For use take one part of No. 2 and dissolve it in 100 parts of No. 1. This developer is one of the best known; it possesses all the advantages of the other developers, without their disadvantages.

Iron Developer.—No. 1. 120 gr. of *Citric Acid,* 88 gr. of *Carbonate of Ammonia,* 1 oz. of *Distilled Water.* No. 2. 140 gr. of *Sulphite of Iron,* 1 drop of *Sulphuric Acid,* 1 oz. of *Distilled Water.* To 3 parts of No. 1 add 1 part of No. 2.

Ferrous Citro-Oxalate Developer.—No. 1. 1 oz. of *Neutral Oxalate of Potash,* 2½ oz. of *Bromide of Potassium,* 5 oz. of *Hot Distilled Water.* No. 2. 2 drm. of pure *Proto-Sulphate of Iron,* 2 oz. of hot *Distilled Water.* Mix together 2 parts of No. 1 and 1 part of No. 2.

Pyro Developer.—Dissolve and keep in tight fitting stoppered bottles. No. 1. 50 grn. of *Pyrogallic Acid,* 150 gr. of *Sodium Sulphite,* 10 gr. of *Citric Acid,* 1 oz. of *Distilled Water.* No. 2. 50 gr. of *Potassium Bromide,* 1 oz. of *Water.* No. 3. 2 drm. of *Ammonia* (0.880), 2¼ oz. of *Distilled Water.* Take 1 part of each and mix.

Tintypes Developer.—1 oz. of *Distilled Water,* 14 grn. of *Sulphate Iron,* 10 gr. of *Saltpeter,* 30 min. of *Acetic Acid,* 2 min. of *Nitric Acid.*

BROWN OR SEPIA TONES ON BROMID AND GASLIGHT PAPER.

Photographic Printing Paper:—

SOLUTION No. 1.—Bleaching Solution.
Bromid of Ammonia..... 1 oz.
Water .....16 oz.

SOLUTION No. 2.
Ferricyanid of Potassimu..... 1 oz.
Water .....12 oz.

SOLUTION No. 3.—Browning Solution.
Sulfid of Soda..... 1 oz.
Water .....12 oz.
(Do not confuse *Sulfid* with *Sulfite.*)

Directions for Brown or Sepia Tones on Bromid or Gaslight Photographic paper:—Take a print from the negative in the usual manner, develop and fix; when thoroughly washed, place in developing tray, and develop till image becomes faint in:—

Solution No. 1..... 4 oz.

Solution No. 2..... 4 oz.

Mix together in container bottle; label bleaching fluid.

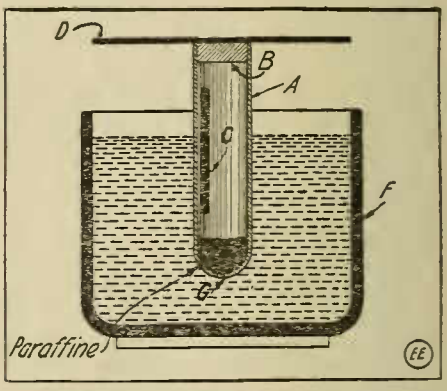
Wash once only, (too much washing will spoil the work); the solutions will keep indefinitely. After washing the print, fill the developing tray with water, placing the print in the tray with the water, and add a teaspoonful of browning solution).

SOLUTION No. 3—Develop till the desired tone is acquired, and wash well in running water.

Solution will not keep.

A SIMPLE WEIGHING BALANCE.

A fairly sensitive scale can be made in a few minutes as follows: Take a test-tube A of about 1 inch diameter by 8 inches long, and put into it some melted paraffine G so that the tube floats upright in water. Fit a cork stopper B into A and glue to B a round tin or brass disc D of about 4 inches diameter. Put the tube A in a glass F containing water. Next put known weights, say ¼, ½ and 1 ounce, on D and mark the waterlevel for these different points on the tube. Prepare a strip of drawing paper and graduate it to suit these marks of ¼, ½ and 1 ounce. Paste this paper scale inside the tube A, taking care to get it in the right place, and the balance is completed. A balance of this type has



Small Weighing Balance Made from Test-tube and Vessel Containing Liquid.

no parts to get out of order and will serve very well for weighing photographic chemicals, etc.

VALUABLE HINTS FOR PHOTO WORKERS.

BOTTLES.—Better to send the unknown contents of a bottle down the sink than risk spoiling a formula with it. Do not wait for labels to drop off; give the lot an inspection every three or six months, and replace any which are becoming illegible. Don't wait till this has happened.

LABELS ON BOTTLES CONTAINING SOLUTION.—Place the label in such a position that you can indicate by an arrow point on the label just how far up in the bottle the stock solution comes when making up a fresh lot.

WASTE BOX.—Do not throw spent matches, plate-box wrappers, bits of string, or anything else (not even cigarette ends) on the floor, but in the waste box (a large-size biscuit tin is just the size and shape). Everything on the floor makes for dust.

SECONDS PENDULUM.—A little over a yard of fire string, the bob of an old clock, a long bit of brass chain. This clinks against the rim of a half-pound tobacco-box lid every second swing. The pendulum hangs from a nail in the wall. The pendulum is forty inches long.

COTTON-BATTING BOTTLE.—This bottle contained caustic potash solution. The stopper being fixed resisted "firmly but gently" every persuasive invitation to move it. It was tapped off at the neck. The shoulder of the bottle was cut with a file scratch and hot wire. The sharp edge taken off with a hard pebble. It now stands on the sink shelf, and holds cotton batting with which to swab the surface of a negative or use as a quick filter.

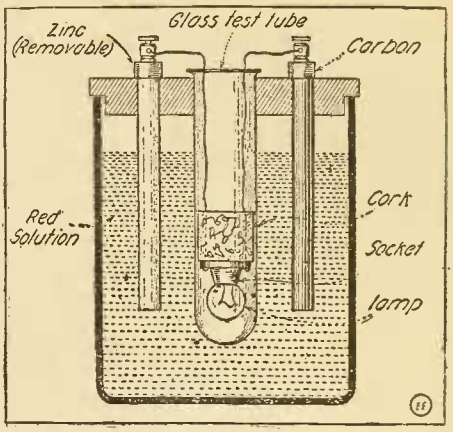
TOOTHBRUSH BONE HANDLE.—Filed down to make a finger-nail shaped end, which acts admirably as a plate lifter.

IMPROVED BICHROMAT DARK-ROOM LAMP FOR PHOTOGRAPHERS.

Some time ago there appeared a description of the above type lamp which shows a battery and rheostat connected in the external circuit to light the lamp within the red solution of Bichromat of Potash.

Here is described an improvement which is more convenient, less expensive and yet one which will give good service. Place a carbon and zinc within the bottle and connect them to the lamp. Put the following solution in the bottle; dissolve 24 ounces of Bichromat of Potash in 1 gallon of water and then slowly add 72 ounces of Sulfuric Acid. If only one-quarter of solution is desired use one-quarter of the above amounts.

For the lamp procure one of the lamps now used in operation with a one or two cell dry battery flash-light; they can be bought in the 5 and 10 cent stores for a dime.



Improved Idea for Making a Photographer's Dark Room Lamp Which Incorporates the Battery, Lamp and Red Coloring Solution All in One Jar.

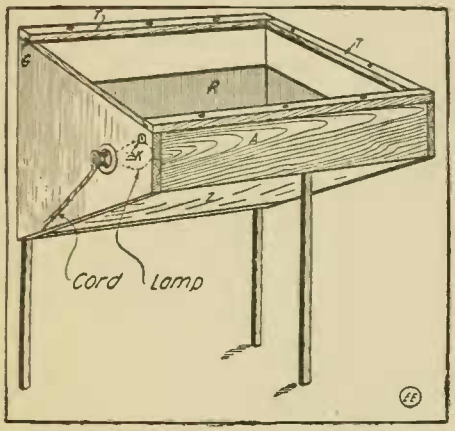
This battery will give about 2½ volts and can be used for constant service. The zinc will last much longer if first dipped in sulfuric acid solution and rubbed quickly with mercury. To open the lamp circuit remove the zinc rod.

HANDY PRINTING AND DARK ROOM LIGHT.

The ordinary light used in a photographic dark room has several disadvantages, namely: it does not allow one to print by the same light and when used as a dark room lamp does not throw the necessary illumination on the developing trays.

This one, however, has neither of the above objections in the idea outlined here as will be seen from diagram. The top, which works in groove G, has either a wooden frame holding a piece of red glass or red celluloid. A handle may be fastened to the red glass by a compound. The front piece A is pivoted on screws K, at end of the frame. By pulling out the lower edge, the sheet of ground glass R, between the printing frame and lamp may then be inserted after the bulb has been screwed into socket.

When printing, the slide of red glass on top is closed and the printing frame placed on top with light turned on; the negative or paper can be seen by placing them so that the light will shine through them.



Home-made Electric Printing and Dark Room Lamp Combined, Which Will Prove Extremely Useful to the Amateur Photographer.

All corners and edges of the case should be made light-weight. Z is a sheet of red glass through which the developing light falls. The glass may be either held in small grooves rabbeted in or by small grooved moldings.

A SIMPLE WAY TO MAKE YOUR OWN VELOX PAPER.

Take any smooth piece of paper about 4″ x 4″ (glossy paper is best) and cover with a coating of silver nitrat ($AgNO_3$), using a camel's hair brush. If this is exposed under a good negative toward the sun a fine print will be obtained of a delightful dark brown. It can be fixed in sodium thiosulfate (hypo.) about 5 grams to 200 c.c. of water. Do not leave in solution over three minutes, as it will take the color out of the print. Then wash.

TO PRINT A PICTURE FROM THE PRINT ITSELF.

The page or picture is soaked in a solution, first of caustic potash and then of tartaric acid. This produces a perfect diffusion of crystals of bitartarate of potassa through the texture of the unprinted part of the paper. As this salt resists oil, the ink roller may now be passed over the surface without transferring any part of its contents except to the printed part.

EMERGENCY BLUE-PRINTING.

Recently there was occasion to make a blue-print drawing in a hurry, but found neither a frame nor the blue-print paper large enough for the work at hand, so the following kinks came in handy. To make a frame take down a picture from the wall and remove everything except the glass and frame. Then screw four pieces of spring copper on it as shown in the drawing. The size of the picture frame was 16x20 and, having two backs for the regular 8x10 photographic frames, fix them up as shown. This frame proves to be very serviceable and fills the requirements which are needed.

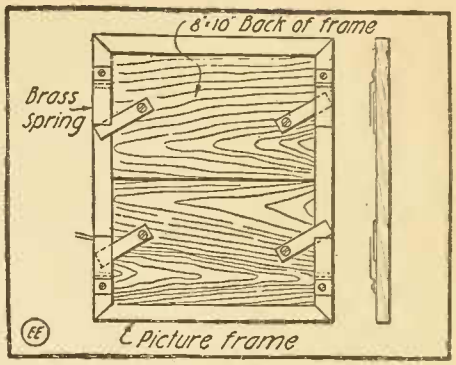
To make the blue-print paper proceed as follows: Obtain a fairly good grade of drawing paper (Rives or Saxe paper, if it can be obtained), and cut down to the required size. Next make up a blue-print solution as follows:

Solution A.—Water, 2 ounces; potassium ferricyanide (red prussiate), 120 grains.

Solution B.—Water, 2 ounces; ammonia citrate of iron, 140 grains. (Any proportion of the above can be made.)

When they are thoroughly dissolved, mix and filter, and always keep in a clean bottle. Be careful not to let too much strong light act upon this solution.

The best way to sensitize the paper is to work by an orange light similar to the light used in bromide printing in photography. Float the paper on this solution until it lies perfectly flat. Do not take it out of the solution carelessly, but slide it out by grasping two corners, sliding it over the surface of the water. If it is desired to keep some of the paper for future use this can be done by rolling it up, with the sensitized surface on the inside, and keeping in a tin box free from light.



Making an Emergency Blue-Printing Frame of Large Size.

Blue-Print and Other Papers.

BLUE PRINTING.

To obtain *white* lines on a *blue* ground:

SOLUTION No. 1.
Ammonia Citrat of Iron.....1 oz.
Water .....4 oz.
SOLUTION No. 2.
Ferricyanid of Potassium.....1 oz.
COATING SOLUTION:

Directions—Mix equal portions of solution No. 1 and No. 2. Coat the paper with a camel's hair brush (like painting) or rub on solution with a tuft of absorbent cotton. Any good bond paper will do, a mat surface writing paper is good. Paper should be dried after coating in a dark room, develop in water.

HOW TO COUNT PAPER SHEETS RAPIDLY.

Below is given a formula for the rapid counting of paper sheets. This method has been used and found to be very accurate:

First, the thickness of one sheet of paper is measured in thousandths of an inch with a micrometer, then measure the total thickness of the sheets of paper to be counted. The total thickness is divided by the thickness of one sheet.

BLUE PRINTS AND BLUE PRINTING.

Since the making of plans is so closely allied with practical work it is thought that a few words on the manufacture and use of a blue print paper, which can be made and used by the ordinary amateur with excellent results, would not be amiss.

Solution 1.—Citrate of iron and ammonia, 1 part by weight; water, 5 parts by weight.

Solution 2.—Red prussiate of potash, 1 part by weight; water, 5 parts by weight.

Mix the two solutions in the dark or subdued light, and apply to the paper, with a camel's hair brush or, failing this, a sponge.

The paper is coated by passing the sponge lightly over the surface three or four times, first lengthwise and then crosswise, giving the paper as dry a coating as possible consistent with an even coating. The treated paper is then hung up to dry.

The above paper will require about five minutes to print. For a quick printing paper use a larger proportion of the citrate.

A blue print is made in a printing frame similar to that for printing pictures. The process is, briefly, to expose the tracing, with the blue print paper under it for a proper length of time, and then remove the paper and wash it in water. To print place the tracing with its face against the glass of the frame. Then lay the paper with its sensitized side next the tracing. The back of the frame is then clamped in position and the frame turned over so that the glass is up and the rays of the sun will fall on it at right angles. The above operations should be carried out in the dark or dim light.

When the exposure is finished remove the print, wash it in clear water and hang up to dry in the dark.

Should any lines or dimensions have been left out of the tracing they may be put in the print, using a solution of baking soda in water and an ordinary pen.

THE PREPARATION AND USE OF BLUE-PRINT PAPER.

The following describes the manufacture of blue-print paper in terms that can be easily understood by any one. No difficulty should be experienced in either the making or the use of the paper.

In order that the best results be obtained it is necessary that good material be used. All vessels in which the solution is made should be kept clean and when not in use should have water in them as far as possible. Do not use soap when washing the trays, as the least trace will do harm to the solution.

Where ordinary work is to be done, any kind of well sized paper will answer, if tough enough to be washed. Different grades of unsensitized papers can be bought at engineers and photo supply houses.

The following formula is for a good solution that will give excellent results to the amateur; this solution is made up of two salts, dissolved in water and applied to the surface of the paper:

Solution No. 1.

Ferrocyanid of potassium.... 1 oz.
Pure or distilled water..... 6 oz.

Solution No. 2.

Ammoniocitrat of iron .... 1 oz.
Pure or distilled water .... 6 oz.

When solutions are to be used mix equal parts of 1 and 2 and filter through cotton or filter paper. This solution we will call No. 3.

The solutions should be applied to the paper in a dark and dry room with a very subdued light—just enough to barely see by.

Small sheets of the paper may be best covered by floating upon the surface of No. 3. This is done by taking a sheet by two diagonal corners and laying it gently on the surface of the solution. This method does away with the possibility of air bubbles forming.

One minute or less will be sufficient for sensitizing. Remove the paper by drawing over the edge of the tray to remove any surplus liquid. Take care to prevent any solution from getting on the back of the paper.

Large pieces are best sensitized by tacking down upon a smooth table with thumb tacks and painting the solution on with a wide camel's hair brush Take care to get it on quickly and evenly. Dry the paper by hanging up by its corners to a wire so that it will swing free. Before sensitizing a batch of paper it would be best to make a trial sheet and print it. The solution may not be mixed properly or the paper may be too absorbent, in which case the solution will go into the paper and will not come out when washing, thus causing the print to fade in a short time.

After the paper has dried hard and without the slightest trace of dampness it should be rolled up and put into an airtight (tin or cardboard) tube and kept in a dark and dry place.

Printing is the exposing of the sensitized paper to the action of a powerful light with the copy to be printed placed over the paper. The direct rays of the sun are best for printing, but the electric arc is nearly as quick and has the advantage of being always constant—regardless of weather.

The drawing, tracing or negative is placed in the frame next to the glass with the paper under it, having its sensitive side up. Exposure will vary from two to ten minutes, according to the light and tracing. The correct time is only found by experience.

After the paper is sufficiently exposed, it is taken from the frame and immersed in a bath of clean running water. A print should be washed for not less than fifteen minutes or it will fade when placed in the light.

Excellent prints may be made in the following manner: Slightly expose the print so that when it is washed the white lines are not clear but appear bluish. Take the print out of the bath and lay it on a table and sponge it with a solution made up of one pound of bichromate of potash and two gallons of water. The lines will come out pure white and the background an intense blue. Wash print thoroly and dry.

White lines may be added to blue prints by the use of a solution made of soda and water to which a small quantity of prepared chalk has been added to thicken it. This solution may be applied with a ruling pen. Engineers generally use a white, red or yellow pencil for making corrections.

EXPLOSIVE PAPER.

Dissolve some Iodine crystals in aqua-ammonia; the amount makes no difference and the crystals should not be entirely dissolved for best results. Then pour the solution in a filter paper to filter. The precipitate should then be put on different pieces of paper and left to dry. When dry the paper will explode if touched; the thicker the precipitate has been put on the paper the louder the report. A joke can be played by anyone by placing it, when almost dry, where they will touch it when it is dry. Don't handle when dry because it will explode very easily. The explosions are harmless to anyone but they cause heat and for this reason care should be taken where they ignite. The correct proportion can best be found by experiment, since it differs with the material. I found 1 part of Iodine to 5 parts of ammonia to give good results.

POLE TEST PAPER.

Undoubtedly many amateur electricians have been annoyed by the trouble in finding which was the positive, and which was the negative of the two wires, especially when the source of current could not be reached or where the wires were twisted so as to make it difficult to distinguish one from the other. In storage cells and batteries the poles are frequently not marked and to find the positive and the negative poles one will have to resort to a polarity indicator, which is an expensive instrument for most experimenters.

A simple method of getting rid of this annoyance with but little expense is as follows: At a drug or chemical store procure some red litmus paper and thoroughly soak it in a solution of one tablespoonful of salt in a tumbler full of water. When thoroughly soaked remove the paper from the solution and carefully, so as not to tear it.

Hang it up to dry in such a manner that it will not touch anything but the means of support.

Note:—Do not try to dry the paper between sheets of blotting paper as this will absorb some of the salt solution and render the pole test paper insensitive to small voltages.

When dry the pole test paper is ready for use. It is used as follows: Take a strip of the paper measuring about one-half inch by one and one-half inches and moisten it slightly with water. Then place the ends of the wires to be tested on the paper in such a position that they will be about three-quarters of an inch apart.

If there is a potential difference (voltage) between the two wires, a deep red spot will appear on the paper at one of the wires and a blue spot will appear at the other wire. The wire at which the blue spot appears is the *negative* and the one at which the red spot shows up is the *positive*.

When the potential difference between the wires is low the red spot will sometimes not show. As the blue spot, however, will appear, it will indicate the negative wire; the other, therefore, being positive.

If you cannot obtain red litmus paper, use blue litmus paper instead. The blue spot, however, will not show up very noticeably in this case, but the red spot will indicate the positive wire and the other wire will therefore of necessity be the negative one.

If unable to procure litmus paper, it can be prepared as follows: Boil some red cabbage leaves in water until a concoction of a deep reddish purple is obtained. Treat this concoction with a few drops of white vinegar until it turns to a brighter red color. Into this solution dip pieces of filter, blotting or unglazed paper. When dry the color of the paper should be a deep pink. If it is lighter the red cabbage solution should be boiled longer.

The paper thus treated can then, after drying, be treated with the salt solution to make the pole test paper as previously described.

After using pole test paper it can be dried and laid aside to be used over again. After it is worn out it may be renewed as follows: Dip into vinegar until all blue spots disappear, then dip into water so as to remove the vinegar, then soak in salt solution as described above and the paper will be as good as new. This can be repeated any number of times until the paper tears.

AN ACID THAT SETS FIRE TO PAPER.

Perchloric acid is one of the most energetic oxidizing agents known. The concentrated acid contains 63.68 per cent of oxygen, with a portion of which it parts most readily in contact with combustible materials. If a drop of the acid is allowed to fall upon a piece of paper, the latter is ignited. It explodes with charcoal, and also, but more violently, with ether. In appearance, perchloric acid resembles sulphuric acid, being a colorless oily fluid, 1.78 times as heavy as water.

MAGIC PAPER.

Take lard oil, or sweet oil, mixed to the consistence of cream, with either of the following paints, the color of which is desired: Prussian blue, lampblack, Venetian red, or chrome green, either of which should be rubbed with a knife on a plate or stone until smooth. Use rather thin but firm paper; put on with a sponge, and wipe off as dry as convenient; then lay them between uncolored paper, or between newspapers, and press by laying books or some other flat substance upon them until the surplus oil is absorbed, when it is ready for use.

Directions.—For taking off patterns of embroidery place a piece of thin paper over the embroidery to prevent soiling; then lay on the magic paper, and put on the cloth you wish to take the copy on, to embroider; pin fast, and rub over with a spoon handle; and every part of the raised figure will show upon the plain cloth. To take impressions of leaves on paper, place the leaf between two sheets of this paper, and rub over it hard, then take the leaf out and place it between two sheets of white paper; rub again, and you will have a beautiful impression of both sides of the leaf or flower.

STICKY FLY PAPER.

Resin, 1 lb.; Molasses, 3½ ounces. Boil until thick enough.

TRICK CIGARETTE PAPERS.

Take common cigarette papers and dip them into a solution of saltpeter and water; be sure they are thoroughly impregnated, then lay them out to dry. When they are dry replace them in their original package and hand them to a friend. He will receive the surprise of his life.

ARSENIC IN WALL PAPER.

The following simple test, for arsenic in wall paper, which will answer all purposes is given: Take some of the coloring matter from the suspected paper and dissolve it in a little ammonia hydroxide. Pour off the solution on a piece of glass and drop into the liquid a crystal of silver nitrate. A yellow color around the crystal will indicate the presence of arsenic.

TO TRANSFER ENGRAVING OR PRINTS.

Place the engravings or prints for a few seconds over the vapor of iodine. Dip a slip of white paper in a weak solution of starch and when dry in a weak solution of oil of vitriol. When again dry lay the paper on the engraving and place both for a few moments under a press.

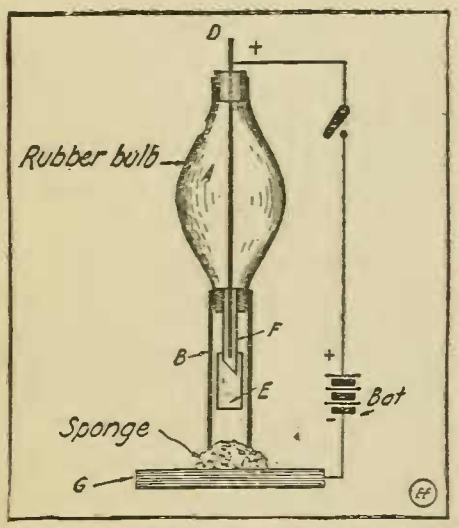
TO MAKE WATERPROOF PAPER.

Paint with equal parts copal varnish. boiled linseed oil and turpentine.

Plating.

A HAND ELECTROPLATING OUTFIT.

The plating outfit consists of a rubber ball, A, fitted at one end with a glass tube, B, which carries a small sponge. Rod D passes through the rubber ball into the glass tube, B, and carries at that end the anodè E. A small glass tube, F, also connects the rubber ball with the larger tube, B. The connections from the battery to the cathode G, the object to be plated, and to the projecting end of the anode carrying rod D are



A Neat System of Electroplating, Eliminating the Usual Muss and Trouble.

made as in the diagram. The rubber ball is filled with the electroplating fluid and is squeezed so as to force the fluid through the small tube, F, into the larger tube, B, filling it and soaking the sponge.

The current is then turned on and by moving the wet sponge over the cathode, G, the latter will be plated.

SILVER PLATING WITHOUT A BATTERY.

Dissolve about an ounce of silver in two ounces of nitric acid. After the silver is all dissolved throw into it a pint of water and four ounces of common salt. The salt will precipitate a powder which is pure silver.

Filter off the water, or if there is no filter paper handy, pour off the water and repeat until all the effects of the salt have disappeared. To this white powder add two ounces of cyanide of potassium* and three ounces of hypsosulphate of soda. Now add to all this two quarts of pure rain water and the silver mixture is complete.

The plating is done in the following manner. Hang the article to be plated in the solution at the end of a strip of lead or if more convenient, immerse the article in the solution and boil it for ten or twenty minutes, according to the thickness of the silvering desired. To obtain best results the articles to be plated must be free from grease and oil or dirt.

SILVER PLATED PENNIES.

In a solution of mercuric nitrate place a cent so that the coin will be completely covered by the liquid. A chemical reaction immediately takes place; the copper, having a greater affinity for the nitrate than the mercury, forms a copper nitrate, causing the mercury to be deposited on the cent, which gives it a silver-plated appearance.

If mercuric nitrate cannot be bought it can easily be made by dissolving a small globule of mercury in a little concentrated nitric acid, warming, if necessary, to start the reaction.

A GOOD SILVER-PLATING SOLUTION.

This solution will be found of excellent use in silver-plating different parts of electrical apparatus, jewelry, etc. Copper, Brass and German silver articles only can be plated.

Cut a silver quarter into small pieces and place in a porcelain or glass dish. Place the dish, uncovered, in a pan of warm water and add ½ ounce of nitric acid to the metal.

*This chemical is a deadly poison and must be handled with the most care.

Let dish stand in the water until metal is all dissolved. Now add ½ gill of water and one teaspoonful of fine salt. Let the precipitate settle and filter. Add more salt to the filtrate, and if any more precipitate falls filter again. Wash the precipitate on the filter paper until the water shows no acid when tested with filter paper. Add one pint of water to the precipitate and four scruples of potassium cyanide. Great care must be used in handling the cyanide, or the solution after it is added, as it is a deadly and almost instantaneous poison. Put a piece of zinc about 2x1x⅛ inches in the solution and it is ready for use.

No electric battery is needed. Simply clean the articles to be plated in a hot potash solution and rinse good in boiling water. Immerse in the solution for about ½ minute, allowing the article to rest on the zinc. Wipe dry with a cloth and repeat. Heavier coatings can be given by repeating. Articles will take a high polish and wear fine.

SILVER PLATE.

Dissolve in silver nitrate ($AgNO_3$) enough ammonium chlorid (NH_4Cl) to bring about precipitation; cream to a light paste by adding cream of tartar ($HKC_4H_4O_6$). A little of this paste rubbed briskly on clean metal with a soft cloth will give the desired effect.

SILVER-PLATING GLASS.

To silver-plate glass first have the glass clean. To clean it well wash it first with an alkali and then with distilled water.

Now dissolve 7.8 grammes of silver nitrat in 60 c.c. of water and divide the solution in two equal portions. Dissolve also 3.11 grammes of Rochelle salt in 1180 c.c. of water and heat the solution to the boiling point. Add to it gradually, so as not to stop the boiling, one of the portions of the silver solution, boil 10 minutes longer, cool and decant the clear liquid.

To the other half of the silver solution add just sufficient ammonia water to dissolve the precipitat which is formed, or only leave a faint cloudiness; then add 360 c.c. of water and filter. Equal portions of these two solutions, when mixed and poured on glass, will deposit a brilliant coating of silver in about 10 minutes, depending on the temperature of the room.

The coating of silver should then be well washed, dried and varnished.

TO SILVER BRASS OBJECTS.

Mix 3 parts chloride of silver, 20 parts powdered cream of tartar, 15 parts powdered common salt. Moisten a suitable quantity of the mixture with water, rubbed in with a piece of blotting paper. Take the blotter, which should be moist, and rub the article (brass) to be silvered. Wipe off any dust on the article and rub with a piece of cotton which has been dusted with precipitated chalk. Then wash in water and polish with a cloth.

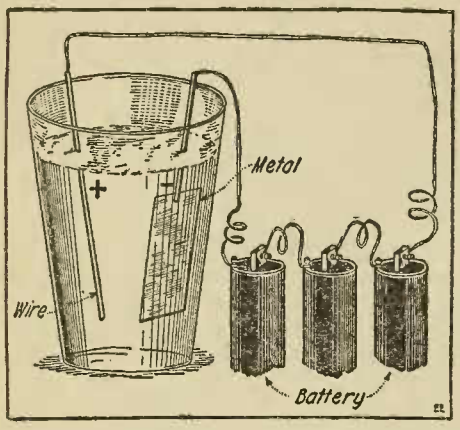
SILVER-PLATING STEEL.

A silver plating for steel can be made as follows: Lunar caustic, 11 parts; sodium hyposulphit, 20 parts; sal ammoniac, 12 parts; whiting, 20 parts, and distilled water, 200 parts, mixed together. Before applying the silver plating to the article clean off all grease.

ELECTRO ZINC PLATING.

To zinc plate steel and other metallic objects mix together about 4 drams of zinc sulphate with 4 ounces of water. Place this solution in an ordinary glass jar; next fasten a wire to the positive pole of a battery. Let this wire lay submerged in the solution. The wire which you have fastened to the negative pole of the battery should be arranged so that it will hold some metal object which is to be zinc plated.

Drop the wire with object to be plated in the solution. Care must be taken not to let the two wires touch, for this will cause a short circuit of the battery. Using a 4-volt



It's Easy Enough to Zinc Plate an Article, as You Will Find in Following the Instructions Herewith.

60-ampere hour storage battery the action of the solution will be much quicker and the quicker will the zinc deposit itself on the object connected to the cathode.

LINING FOR PLATING TANKS.

In pickling, plating and other metal treating processes the lining for the acid-holding tanks requires certain qualities to resist the corrosive action of the acids. A mixture consisting of 75 parts (by weight) of pitch, 9 parts plaster-of-paris, 9 parts ochre, 15 parts beeswax and 3 parts litharge is said to form an efficient lining for this purpose.

COPPER PLATING WITHOUT ELECTRICITY.

With this copper-plating solution an article can be plated in two minutes without any electric current:

Formula: Add to 350 C.C. of water 25 C.C. of pure sulphuric acid, 1 tablespoonful of copper sulphate crystals, 2 tablespoonfuls of ammonium chloride (Sal Ammoniac).

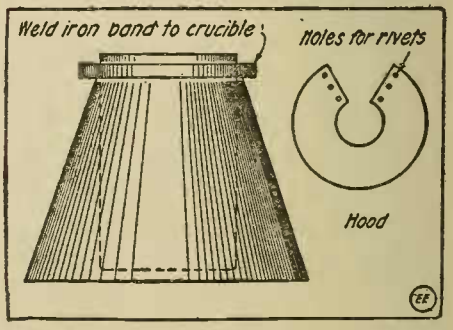
One small teaspoonful sodium bicarbonate (baking soda). This solution will not copper-plate silver, zinc, aluminum, lead or carbon, but gives tin, tool steel and nickel a fine plating. Clean the article thoroughly, then dip in the solution for about two minutes. Remove and wipe off the solution. Dip in again for two minutes and after wiping, polish the article.

COPPER PLATING.

To copper plate a small steel object proceed in this way: Put ½ teaspoonful of sodium bisulphate in 1/5 glass of water. Now add ¼ teaspoonful of azurite. Heat gently to dissolve the substances. Dip the article that is to be plated into the solution and leave for about one-half minute, and dry on a cloth.

DIRECTIONS FOR WHITE METAL PLATING.

A number of firms have advertised white metal plating outfits, for plating knives, forks, spoons, etc., for which they charge from ten to twenty dollars. By following the instructions given below, you can, with the assistance of a blacksmith in making the crucible and hood, set up this outfit complete for about two dollars and a half or less.



How Crucible is Made for White Metal Plating.

To make the hood—Make a flaring gas-pipe 4x6 inches, weld a bottom in it, and a band around the top from which it hangs inside the hood.

To make the hood—Make a flaring cylinder of sheet iron, the small end the proper size to fit under the ring of crucible; the other end about one-fourth larger in diameter, and sufficiently long to hold crucible upright with bottom just clear of the stove or gas plate.

To make the White Metal—Pure tin, 10 lbs., lead 4 ozs., antimony 2 ozs. Melt and mix thoroughly. A better grade is made by using 2 ozs. of pure silver in place of the antimony.

Jar No. 1 (Pickle Solution)—For iron or steel is composed of muriatic acid only.

Jar No. 2 (Dip Bath)—Dissolve 2 pounds refined zinc in 2 quarts fluid hydrochloric acid C. P. When dissolved and cold, add half a teacup of clear rain water or filtered water. (This is a dangerous solution to mix, as it is very violent when the zinc is being consumed, and great care should be taken.)

Jar No. 3 (Chill Bath)—Dissolve 6 ozs. di-ammonia carbonate in 3 pints of filtered water. Use at a temperature of 120 degrees F.

Jar No. 4 (Pickle Solution)—For Irish silver and brass, dissolve 12 ozs. granulated nitratum in 2 quarts of filtered water; then add *slowly* 2 quarts commercial sulphuric acid. (Note—Unless you are going to do a great deal of plating, Jar No. 4 is unnecessary, as Jar No. 1 answers as a pickle solution for all metals.)

Stripping Solution—Is composed of 1 pound granulated kali; or potash and 2 scruples of French rouge; dissolved in 1 gallon commercial sulphuric acid.

(*The Flux*)—Mix thoroughly 5 lbs. granulated white ammonia hydrochlorate with 4 drams French rouge. For convenience in using, put a portion in an ordinary tin pepper box.

Directions for Plating—Place the sheet iron hood on the stove or gas plate, the small end up, then set the iron crucible previously filled with the *white metal,* inside the hood, so edge will rest on top of same. But little heat is required to melt the metal, which forms a thin metallic solution. Care should be taken not to get it too hot. If after an article is plated it shows a yellowish color, it is because of too much heat, which should be partly turned off. Proceed to plate as follows:

First, put articles to be plated in Jar No. 1, allowing them to remain ten minutes to remove all rust, etc., then rinse in clear, cold water. Next take one piece at a time and rinse in Jar No. 2 for a few seconds; then immerse the article slowly in the crucible containing the melted metal; raise slowly up and down once or twice, sprinkle a little flux on the article, letting some of the flux fall on the melted metal. Then draw article from crucible and immerse slowly into Jar No. 3, which hardens the plate, after which rinse in clear water and it is finished.

Knives, forks and spoons should be plated, one-half at a time; then the operation reversed. About one minute is required to plate a single article. A little practise will make you perfectly familiar with plating in this manner, and you will be able to see at a glance when everything is perfect. When there is much old plate on an article, place stripping solution in a crock, heat it, and immerse article therein until the old plate is all removed; then rinse in clear water, dry with a chamois skin, and proceed to plate as above.

(Special Note)—When much old plate is removed by stripping, it pays to reclaim the silver, which may be done in the following manner: Add common salt to the stripping solution as long as it throws down a precipitate, then pour off the solution. Wash the precipitate with clear water, then add a few small pieces of sheet zinc to it and let stand until the precipitate turns to a black powder, which will take several hours.

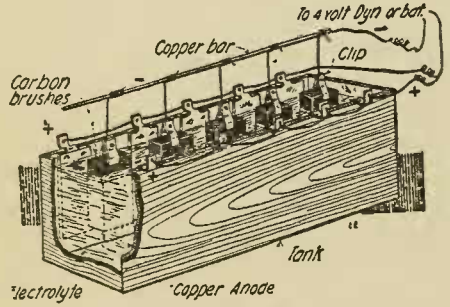
Then wash the powder several times in warm water, dry between sheets of blotting paper, and pick out the pieces of zinc. The powder will be pure silver which you can melt and run into bars.

COPPER-PLATING CARBON MOTOR BRUSHES.

It is usual to thoroughly copper plate the better class of motor and dynamo brushes made of carbon to improve their surface conductivity, and this may be accomplished in the following manner:

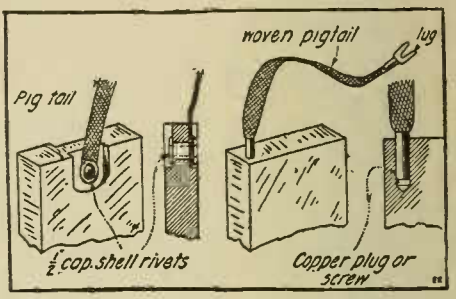
The carbon brushes are usually cut from flat carbon plates of the desired thickness and measuring 12 by 12 inches. They are cut out in strips, which are then separated into the proper lengths by means of a high speed carborundum or corundum wheel about ¼ inch thick and 12 inches in diameter.

The brushes are first washed thoroughly and after drying they are dipped in pure paraffin, when they are placed in a bake oven and heated at 110 to 115° F. temperature for 20 to 30 minutes.



Copper Plating Carbon Brushes in Electrolytic Bath.

They are copper plated by immersing in an electrolyte bath. For small tanks the bath is prepared by mixing two pounds of copper sulphate with one gallon of water and adding ammonia until the precipitate first formed is just redissolved. This colors the solution blue. Potassium cyanid is then added until the blue color disappears. This bath should be used at a temperature of 122° F. to 131°F. Another bath, which may be used cold, is composed of a copper sulphate solution with 1/10 of its volume of sulphuric acid. Its density should register 1.197. This bath cannot be used for metal objects attacked by the above chemicals.



Details of Method Used in Firmly Securing Pigtail Connections to Carbon Brushes.

Pure copper anodes are placed in the bath, and these may be cut from pure copper sheets about ⅛ inch thick. The carbon brushes are held by spring clips, resulting in about ½ inch of the brush remaining unplated, but this is all right, as the unplated edge is the one ground down to fit the commutator curvature, and the copper plated surface need not necessarily reach the commutator.

The electric current required for a small plating tank is 15 to 20 amperes at 3½ to 4 volts, and a regular electro-plating generator is best employed. The brushes are plated from 4 to 6 minutes generally, but this will vary with the temperature of the electrolyte and the amount of current used.

A litle experimenting will soon tell as to how long the brushes should be plated and as to the proper strength of current. It should be possible to regulate the latter by means of rheostat. If the plating is done too rapidly by using too strong a current then the metal deposit on the brushes will tend to peel or turn black. Hints are given in the illustration for attaching the "pigtail" connectors.

TIN PLATING.

To tin-plate a small article like a copper penny or a copper statue proceed this way. Put a half teaspoon of tartaric acid in a bright and shiny tin cup. Put the article in the cup and fill the latter about three-fourths full of water and set on stove to boil. Boil till water is nearly all driven off. The article is now tin-plated and a little polishing will make it shine as bright as a new dime. In this experiment the tartaric acid dissolves the tin and plates the object which is in the cup.

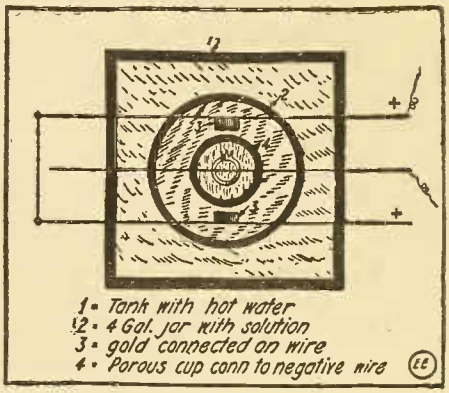
The object to be plated must be clean and free from dirt or it will plate unevenly. To clean the article dip in weak sulphuric acid and dry.

GOLD PLATING WITHOUT A BATTERY.

Clean the article to be plated with a brush and ammonia water until it is bright and untarnished, then take a small piece of gold and dissolve it in four times its volume of metallic mercury, which forms an amalgam. With a dry cloth rub a little of this amalgam on the article to be plated, then place it on a stone in a furnace and heat to the beginning of redness. After it cools clean with a brush and a little cream of tartar.

"ROMAN GOLD" PLATING SOLUTION.

When making the solution, obtain a porcelain jar that holds 4 gallons of water. Fill it almost to the top with clean water and set the jar in a tank of water. Keep the water boiling while you are using the solution, for if the solution is cold the work will smut up, instead of having an even Roman Gold finish. Next dissolve 8 ounces of potassium cyanide in the 4-gallon jar. After the cyanide is all dissolved place into the 4-gallon jar a porous cup that holds about 1 quart of water. Into the porous cup pour 4 ounces of cyanide; let this dissolve also. Suspend the porous cup on center wire as per diagram. Put 10 pwt. of fine ribbon gold on both sides of the electric wire, making 20 pwt. in all. The gold will dissolve into the 4-gallon jar in about one hour and a half. After it is all dissolved



Arrangement of Apparatus for "Roman Gold" Plating.

remove the porous cup from the 4-gallon jar and throw away what is left, as it is of no value. Allow the solution to settle about 2 hours before using. You can use gold, platinum or carbon anodes to color with; that is to say, put one anode on each wire, and color on center wire.

SILVER-PLATING POWDER.

Chloride of silver, 3 oz.; salts of tartar, 6 oz.; prepared chalk, 2 oz.; common salt, 3 oz. Mix. Dip a moist cloth in this powder and rub the article to be plated.

SILVER-PLATING FLUID.

One oz. silver nitrate, 12 oz. rain water, Dissolve and add 2 oz. of potassium cyanide. (The latter should be carefully handled, as it is poisonous.) Clean the article thoroughly and apply the fluid by rubbing. The fluid may be used on detector parts, but as the deposited film of silver is not very substantial it would not do for articles which are to be continually carried in the pocket, etc.

COLD SILVERING OF METALS.

Mix 1 part of chloride of silver with 3 parts of pearlash, 1½ parts common salt, and 1 part whiting; and well rub the mixture on the surface of brass or copper (previously well cleaned), by means of a piece of soft leather, or a cork moistened with water and dipped in the powder. When properly silvered, the metal should be well washed in hot water, slightly alkalized; then wiped dry.

GOLD-PLATING WITHOUT BATTERY.

To gild without a battery, use the following process: In 1,000 parts of distilled water dissolve in the following order: Crystalline sodium pyrophosphate, 80 parts; 12 per cent solution of hydrocyanic acid, 8 parts; crystalline gold chloride, 2 parts. Heat to a boiling temperature and dip the article, first thoroughly cleansed, therein. To silver brass, copper, etc., dissolve 10 parts lunar caustic in 500 parts distilled water, and 35 parts potassium cyanide (98 per cent) in 500 parts distilled water; mix both solutions with stirring. Heat to about 194 degrees F. in an enameled vessel, and enter the articles, well cleansed of all grease, until a uniform coating has formed.

Pyrotechny.

COLORED FIRES.

The Preparation of the Mixtures for Colored Lights.—The ingredients must be perfectly dry, in the state of very fine powder; mixed thoroughly but very carefully together on sheets of paper with the hands or by means of cardboard spatulas.

The mixtures are best packed in capsules or tubes about one inch in diameter and from six to twelve inches long, made of stiff writing paper.

Greater regularity in burning is secured by moistening the mixtures with a little whiskey and packing them firmly down in the tubes by means of a wooden cylinder, then drying.

To facilitate ignition a small quantity of the following powder, loosely twisted in thin paper, is inserted in the top:

Ignition Powder.—Sixteen parts of *mealed powder,* 2 parts of *niter,* 1 part of *sulphur,* 1 part of *charcoal.*

White Lights.—Four oz. of *saltpeter,* 1 oz. of *sulphur,* 1 oz. of *black sulphide of antimony.*

Yellow Lights.—Four oz. of *chlorate of potash,* 2 oz. of *sulphide of antimony,* 1 oz. of *sulphur,* 1 oz. of *oxalate of soda.*

Green Lights.—Two oz. of *chlorate of baryta,* 3 oz. of *nitrate of baryta,* 1 oz. of *sulphur.*

Red Lights.—Twenty-five oz. of *nitrate of strontia,* 15 oz. of *chlorate of potash,* 13 oz. of *sulphur,* 4 oz. of *black sulphide of antimony,* 1 oz. of *mastic.*

Blue Lights.—Three oz. of *chlorate of potash,* 1 oz. of *sulphur,* 1 oz. of *ammonia-sulphate of copper.*

Rockets.—One part of *sulphur,* 2 parts of *charcoal,* 4 parts of *niter,* 2 parts of *meal powder,* 1 part of *steel filings.*

Silver Rain.—Two parts of steel filings, 7 parts of *meal powder,* 1 part of *niter.*

Gold Rain.—One part of *sulphur,* 2 parts of *niter,* 1 part of *charcoal,* 6 parts of *meal powder.*

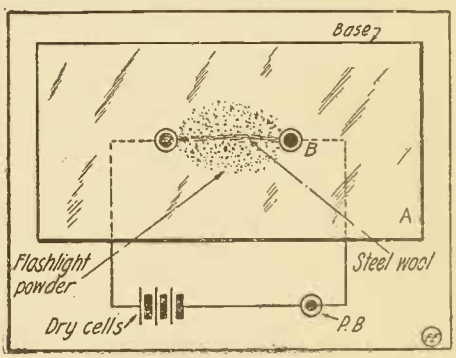
Chlorate Metal Powder.—Fifteen parts of *chlorate of potash,* 3 parts of fine *charcoal,* 2 parts of *sulphur.*

Red Chinese Fire.—Sixteen parts of *meal powder,* 16 parts of *niter,* 4 parts of *sulphur,* 4 parts of *charcoal,* 14 parts of *iron borings.*

HOW TO SET OFF FLASHLIGHT POWDER.

Very often one wishes to set off flashlight powder when taking an indoor picture, etc. A simple way to set off the powder is shown in the diagram.

A is a small base of slate 2 inches by 3 inches. B two binding posts taken from an old battery. Screw the posts on the base



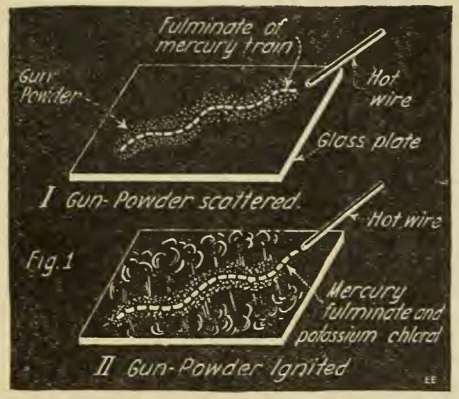
When Current From the Battery is Past Thru the Single Strand of Steel Wool, It Becomes Incandescent; Igniting the Flashlight Powder.

about one inch apart. Procure some fine steel wool from a paint store. Pull out a strand and stretch it between the binding posts. A few dry cells and a push-button are connected as in the diagram.

When a flashlight picture is to be taken pour some powder on the wire and push the button. The wire will become red hot and will ignite the powder. A reflector is put behind the base to increase the light.

FULMINATES.

Much has been written about the guns used in the European War and it is not out of place to dig down to the root of the whole thing and find out what is the real source of the explosion in the gun chamber.



Fulminate of Mercury Alone Will Not Ignite Gunpowder. When Mixed With Potassium Chlorat, However, It Readily Ignites the Gunpowder, Due to the Retardation of the Flash and the Heat Formed.

Most guns are set off by means of a *priming cap* and the substance used inside the priming cap is the subject of this article.

Mercury Fulminate is the active substance in the priming cap. This substance is prepared by the action of alcohol on a solution of mercury dissolved in an excess of nitric acid; and as this action is of a violent character, some care is necessary in order to avoid an explosion. On a small scale, the fulminate may be obtained without any risk by STRICTLY ATTENDING TO THE FOLLOWING DIRECTIONS:

Weigh out, in a watch-glass, 25 grains of mercury, transfer it to a half-pint beaker, add half an ounce (measured) of ordinary concentrated nitric acid (sp. gr. 1.42), and apply a gentle heat. As soon as the last particle of mercury is dissolved, place the beaker upon the table, away from any flame, and pour into it, pretty quickly, *at arm's length,* 5 measured drachms of alcohol (sp. gr. 0.87). Very brisk action will ensue, and the solution will become turbid from the separation of crystals of the fulminate, at the same time evolving very dense white clouds, which have an agreeable odor, due to the presence of nitrous ether, aldehyde, and other products of the action of nitric acid upon alcohol. The heavy character of these clouds is caused by the presence of mercury, tho in what form has not been ascertained; much nitrous oxid and hydrocyanic acid are evolved at the same time. When the action has subsided, the beaker may be filled with water, the fulminate allowed to settle, and the acid liquid poured off. The fulminate is then collected on a filter, washed with water as long as the washings taste acid, and dried by exposure to air.

On a large industrial scale, the preparation of mercuric fulminate is carried out in the open air, under sheds. At Montreuil, 300 grammes of mercury are dissolved in

How to Make a "Throw-Down" Fire-cracker from a Few Quartz Fragments and a Piece of Silver Fulminate, All Wrapt in a Piece of Thin Paper.

3 kilogrammes of colorless nitric acid of sp. gr. 1.4 in the cold. The solution is transferred to a retort, and 2 litres of strong alcohol are added. In the summer no heat is applied, and the vapors are condensed in a receiver and added to a fresh charge.

When the action has ceased the contents of the retort are poured into a shallow pan, and when cold, the fulminate is collected in a conical earthen vessel partially plugged at the narrow end. It is washed with rain-water and drained until it contains 20% of water, being stored in that state.

Mercuric fulminate is represented by the formula $HgC_2N_2O_2$ being derived from the hypothetical fulminic acid $H_2C_2N_2O_2$ by the substitution of Hg″ for H_2. Its production by the action of nitric acid upon mercury and alcohol may be explained by the following reactions:

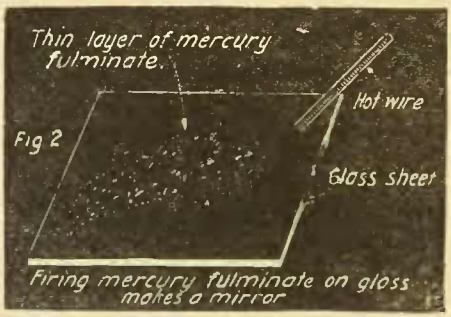
(1) Mercury, dissolved in nitric acid, yields mercuric nitrat and nitrous acid.

(2) Nitrous acid, acting upon alcohol (ethyl hydrat), gives nitrous ether (ethyl nitrit) and water.

(3) Ethyl nitrit, acted on by another molecule of nitrous acid, gives fulminic acid and water.

(4) Mercuric nitrat (formed in the first reactions) may be supposed to act upon the fulminic acid, producing mercuric fulminate and nitric acid.

Properties of *mercuric fulminate.*—This substance is deposited in the above process in fine needle-like crystals, which often have a gray color from the accidental presence of a little metallic mercury. It may be purified by boiling it with water, in which it is sparingly soluble, and allowing the fulminate to crystallize from the filtered solution. Very moderate friction or percussion will cause it to detonate violently, so that it must be kept in a corked bottle lest it should be exploded between the neck and the stopper. It is usually preserved in the wet state, with about one-fifth its weight of water. Its explosion is attended with a bright flash, and with gray fumes of metallic mercury. The violence of the explosion must be attributed to the sudden evolution of a large volume of gas and vapor from a small volume of solid, for the fulminate, being exceedingly heavy (sp. gr. 4.4), occupies a very small space when compared with the gaseous products of its decomposition, especially when the latter are expanded by the heat. One gramme of fulminate evolves 403.5 units of heat, giving an estimated maximum pressure of 48,000 atmospheres. The evolution of heat during the explosion, apparently in contradiction to the rule that heat is absorbed in decomposition, must be ascribed to the circumstance that the heat evolved by the



If a Thin Layer of Mercury Fulminate On a Sheet of Glass is Ignited, Metallic Mercury Will Be Deposited, Thus forming a Mirror.

oxidation of the carbon exceeds that absorbed in the decomposition of the fulminate. A temperature of 195 degrees Centigrade explodes fulminate of mercury, and the same result is brought about by touching it with a glass rod dipped in concentrated sulphuric or nitric acid. The *electric spark,* of course, explodes it.

Cap composition.—The explosion of mercuric fulminate is so violent and rapid that it is necessary to *moderate* it for percussion caps. For this purpose it is mixed with potassium nitrat or chlorat, the oxidizing property of these salts possibly causing them to be preferred to any merely inactive substances, since it would tend to increase the temperature of the flash by burning the carbonic oxid into carbon dioxid, and would insure the ignition of the cartridge.

For military caps, in this country, potassium chlorat is always mixed with the fulminate, and *powdered glass* is sometimes added to increase the sensibility of the mixture to explosion by percussion. *Antimony sulfid* is sometimes substituted for powdered glass, apparently for the purpose of lengthening the flash by taking advantage of the powerful oxidizing action of potassium chlorat upon that compound.

Since the composition is very liable to explode under friction, it is made in small quantities at a time, and without contact with any hard substance. After a little of the composition has been introduced into

If Some Fulminate of Mercury is Heated On a Piece of Copper Foil a Slight Explosion Occurs; With Silver Fulminate a Violent Explosion Results.

the cap, it is made to adhere and waterproofed by a drop of solution of shellac in wine.

If a thin train of *mercuric fulminate* be laid upon a plate, and covered, except a little at one end, with *gunpowder,* it will be found on touching the fulminate with a hot wire, that its explosion scatters the gunpowder, but does not inflame it. On repeating the experiment with a mixture of 10 grains of fulminate and 15 grains of *potassium chlorate* (mixed upon paper with a card), the explosion will be found to inflame the gunpowder. (See Fig. 1.)

By sprinkling a thin layer of the fulminate upon a glass plate, and firing it with a hot wire, the separated mercury may be made to coat the glass, so as to give it all the appearance of a looking-glass. (See Fig. 2.)

Although the effect produced by the explosion of mercuric fulminate is very violent in its immediate neighborhood, it is slightly felt at a distance, and the sudden expansion of the gas will burst fire-arms, because it does not allow time for overcoming the inertia of the ball, though, if the barrel escape destruction, the projectile effect of the fulminate is found inferior to that of power. It has been proved by experiment that the mean pressure exerted by the explosion of mercuric fulminate is very much lower than that produced by gun-cotton, and only three-fourths of that produced by nitro-glycerin. Its great pressure is due to its instantaneous decomposition into CO, N, and Hg vapor within a space not sensibly greater than the volume of the fulminate itself, which volume being very small, on account of the high density of the fulminate, the escaping gases exert an enormous pressure at the moment of explosion.

This detonating property of mercuric fulminate renders it exceedingly useful for effecting the detonation of gun-cotton and nitroglycerin. Berthellot finds that even such stable gases as acetylene, cyanogen and nitrid oxid are decomposed into their elements by the detonation of mercuric fulminate. Mercuric fulminate is generally contaminated with mercuric ovalat, which is one of the secondary products formed during its preparation.

Fulminate of silver.—*Silver fulminate* is prepared by a process very similar to that for fulminate of mercury; but since its *explosive properties are far more violent,* it is not advisable to prepare so large a quantity. 10 grains of silver are dissolved at a gentle heat, in 70 minims of ordinary concentrated nitric acid (sp. gr. 1.42) and 50 minims of water.

As soon as the silver is dissolved, the lamp is removed, and 200 minims of alcohol (sp. gr. 0.87) are added. If the action does not commence after a short time, a very gentle heat may be applied until effervescence begins, when the fulminate of silver will be deposited in minute needles and may be further treated as in the case of fulminate of mercury.

(NOTE:—If the nitric acid and alcohol are not of the exact strength here prescribed, it may be somewhat difficult to start the action unless two or three drops of red nitric acid [containing nitrous acid] are added. Standard silver [containing copper] may be used for preparing the fulminate.) Silver fulminate is also prepared when nitrous anhydrid is past into an alcoholic solution of silver nitrate. When dry, the fulminate must be handled with the greatest caution, since it is exploded far more easily than the mercury salt; it should be kept in small quantities, wrapt up separately in paper, and placed in a cardboard box. Nothing harder than paper should be employed in manipulating it. The violence of its explosion renders it useless for percussion caps, but it is employed in *detonating crackers*. Silver fulminate is sparingly soluble in cold water, but dissolves in 36 parts of boiling water.

If a minute particle of the fulminate be placed upon a piece of quartz, and gently prest with the angle of another piece, it will explode with a flash and smart report.

A *throw-down detonating cracker* (Fig. 3) may be made by rolling up a particle of silver fulminate in a piece of thin paper, with some fragments obtained by crushing a common quartz pebble.

The explosion of *silver fulminate* may be compared with that of the *mercury salt,* by heating small equal quantities upon thin copper or platinum foil, when the fulminate of mercury will explode with a slight puff, and will not injure the foil, but that of silver will give a loud crack and rend a hole in the metal. (See Fig. 4.)

If a particle of silver fulminate be placed upon a glass plate and touched with a glass rod dipped in oil of vitriol, it will detonate and leave a deposit of silver upon the glass.

When silver fulminate is dissolved in warm ammonia, the solution deposits, on cooling, crystals of a double fulminate of silver and ammonium, which is even more violently explosive, and is dangerous while still moist. A similar compound is formed with mercuric fulminate.

Silver fulminate is also formed when freshly precipitated silver oxide is covered with a strong solution of ammonia, and allowed to stand for some hours, when it becomes black, and acquires dangerously explosive properties.

Fulminating platinum.—This is obtained by dissolving platinic oxid in diluted sulfuric acid, and mixing the solution with an excess of ammonia, when a black precipitate of fulminating platinum is obtained, which detonates violently at about 400 degrees F.

Fulminating gold.—This is obtained as a buff precipitat when ammonia is added to a solution of auric chlorid; its composition is not well established. It explodes violently when gently heated.

Fulminate of copper.—This is obtained by digesting copper (in the form of powder or filings) with fulminate of mercury or silver and a little water. It forms soluble green crystals which explode with a green flame. There are many other fulminates and they are all explosive.

FOR FIREPROOFING ANY KIND OF FABRIC.

A very good formula for this purpose is as follows:

Boric acid, 50 grams.
Borax, 60 grams.
Water, 1,100 cu. cms.

Paint or soak fabrics in the solution; then either hang up to dry or press fabric with a hot iron.

MAGIC SERPENTS FOR PYRO-TECHNICAL DISPLAYS.

Any of the three formulas given herewith will produce the same effect when properly compounded as the ones which are for sale in the form of a pyramid or an egg.

1. Fuse in a crucible the following mixture: Prussiate of potash 46 parts, carbonate of potash 16 parts, sulphur 32 parts. The heat should not be allowed to go beyond a dull red and the mass should be removed from the fire when thoroughly fused. When cold dissolve the mass in water and filter off the clear portion. To this latter is added nitrate of mercury as long as the precipitate is thrown down, which is washed in many changes of water, collected on blotting paper, dried, rolled into little pyramids or eggs and covered with tinfoil. They are now ready for ignition. The mixture thus compounded is sulpho-cyanide of mercury, which can be produced by the following method if preferred:

2. Metallic mercury is dissolved in dilute nitric acid, taking the precaution of having an excess of the metal. Decant solution and add to it a saturated solution of sulpho-cyanide of ammonium. The precipitate which falls must be collected and washed in several changes of water and finally dried. Mix in a mortar this dried mass with a little gum water to make a pasty mass, but as dry as possible. The compound now formed may be pressed into eggs as already described.

These two compounds as described are both *extremely poisonous*. The next has not this disadvantage and the residue may be used to polish brass.

3. Bichromate of potash 2 parts, saltpeter 1 part, white sugar 3 parts. Pulverize these ingredients separately and mix thoroughly and press into cones of paper. These cones should be covered with tin-foil and varnished.

FIREWORK PAPERS AS PYROTECHNICS.

Red Fire.

Strontium nitrat	20	parts
Potassium chlorat	10	"
Alcohol	20	"
Water	100	"

Green Fire.

Barium chlorat	20	"
Alcohol	20	"
Water	100	"

Yellow Fire.

Sodium oxalat	10	"
Potassium chlorat	10	"
Alcohol	20	"
Water	100	"

Blue Fire.

Potassium chlorat	10	"
Copper chlorat	20	"
Alcohol	20	"
Water	100	"

Violet Fire.

Strontium chlorat	15	"
Copper chlorat	15	"
Potassium chlorat	15	"
Alcohol	50	"
Water	100	"

Lilac Fire.

Potassium chlorat	20	"
Copper chlorat	10	"
Strontium chlorid	10	"
Alcohol	50	"
Water	100	"

Unsized paper is put in the solutions. When the paper becomes saturated, then remove and dry by hanging it over a string stretched across a warm room. A sheet of paper about 12 by 16 inches may be made to burn for several minutes.

CHEMICAL FIRE FORMULAS.

Put 9 drops of glycerol on a small piece of paper in an evaporating dish. Then cautiously place 6 measures of potassium permanganate on the glycerol. Keep your face away. It will burn brightly with a lilac color and carbon dioxid (CO^2) is evolved. The lilac color comes from the element potassium.

The Manufacture of Colored Fire: Mix thoroughly on a piece of paper 4 parts of barium nitrate, 4 parts of potassium nitrate, ½ part of sulphur and 1 part of powdered charcoal. Pour this mixture in an evaporating dish. Apply match. The mass will take fire and burn with green flame.

HAND GRENADES.

It often happens in a laboratory that some inflammable acid is accidently spilled or some chemicals which do not agree be mixed. A very bad explosion or fire is usually the outcome of such mistakes.

A sanitary and safe device can be made by the experimenter at the cost of a few cents which will end chemical fires as quick as they begin.

It consists of a mixture of chloride of calcium, twenty parts; sodium chloride (common salt), five parts, and water, eighty-five parts. Several small thin bottles are purchased, filled with this mixture and corked.

When a fire occurs, one of these grenades should be thrown in such a way that it will break in or near the fire which will quickly be extinguished.

A MAGIC FIRE FLUID.

The magician appears with a small bottle of colorless liquid in one hand and a few pieces of white paper in the other. He proceeds to pour a little of the fluid on the paper and then places the paper on a screen or some other metal support.

Then he steps back; in the meantime explaining to the audience that this magic fluid, invented by the Japanese thousands of years ago, was used by them to torture their prisoners, or relating any similar story to keep the audience interested. In a few minutes, usually about two, the paper will burst into flame spontaneously. The trick is very mystifying to any one who does not understand the principles involved.

However, it is really very simple. The fluid is prepared by dissolving phosphorous in carbon di-sulfid. Be extremely careful in handling the phosphorous, to cut it under water and not to touch it with your hands. Also keep the carbon di-sulfid away from open flames, as it is very inflammable. The odor of the commercial product is rather disagreeable, but this may incidentally add to the mystery of the trick.

What really happens is this: The phosphorous is dissolved in the carbon di-sulfid. When poured on the paper the carbon di-sulfid evaporates, leaving the phosphorous impregnated in the paper (in a finely divided form). This starts to oxidize and soon raises the temperature of some part of the paper to the kindling point.

Practically any kind of paper will do for this trick. Filter and newspaper both work well. The main thing is not to spill it on anything that you do not wish to burn as it works 100 per cent of the time.

HOW TO MAKE BENGAL LIGHTS.

Take 8 parts saltpeter, sublimed sulphur 4 parts, and antimony 1 part and mix well into powder. Beat firmly in stout iron cup and set on fire. Such lights are made use of for signaling long distances at sea. If a little camphor is added it will burn brighter.

TO HANDLE FIRE WITHOUT HARM.

Mercury neutralized in vinegar and the white of an egg smeared on will preserve anything from fire.

FLASHLIGHT POWDERS.

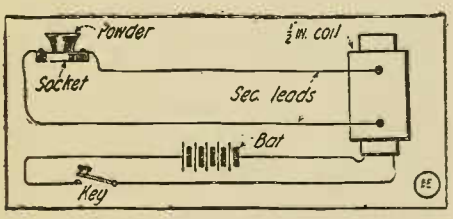
Take powdered magnesium, 3 ozs.; powdered chlorate of potash, 6 ozs.; powdered sulphide of antimony, 1 oz. Mix by sieving. One hundred grams to be used each time a photograph is taken.

LIGHTING A BUNSEN BURNER WITHOUT MATCHES.

If a crystal of potassium chlorat is rubbed on the side of a safety match box, tiny sparks of flame will result. This is due to the combustion of the phosphorus on the box with the oxygen of the potassium chlorat.

USING TELEPHONE MOUTHPIECE AS FLASH-POWDER HOLDER.

An ordinary telephone mouth-piece forms a handy container for flashlight powder which is to be ignited from an induction coil or 110 volt circuit. The mouth-piece is mounted upright on a block of wood with two wires attached to it in such a way that a small spark gap is left inside the mouth-piece. Over this the powder is placed. When the push button in the primary circuit is pressed the induction coil spark jumps the gap, igniting the flash-powder safely and accurately. Keep your face at least 3 to 5 feet from the powder when igniting it, and don't let your hands



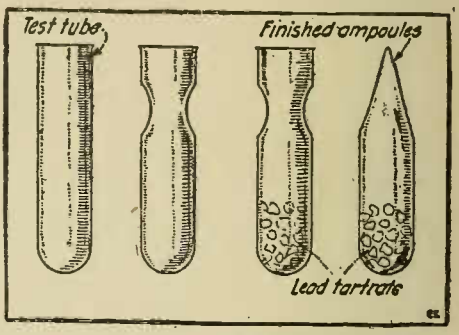
Make a Flash-Powder Holder Out of That Old Telephone Mouth-piece. A Spark Coil Ignites the Powder.

get closer than this either, unless you want a nasty burn.

PREPARATION OF PYROMORPHIC CARBON.

Pyromorphic carbon is a substance which takes fire spontaneously. It is prepared from lead tartrat. To prepare the lead tartrat mix solutions of tartaric acid and lead acetat. Lead tartrat is precipitated. This is filtered, washed and dried in the air.

Next an ampoule is prepared by drawing out a test tube. (See diagram.) The tartrat is now put in the ampoule and heated until no more white fumes are given off. It is then sealed at the constriction



An Interesting Chemical Experiment of Spontaneous Combustion.

before cooling. After it is thoroughly cooled and if the tip is broken off the substance when sprinkled out will burst into flame before reaching the floor.

On heating, lead tartrat decomposes, leaving lead and carbon. These are in such a finely divided state that they absorb oxygen —thereby bursting into flame.

AN EXPERIMENT WITH "THERMIT."

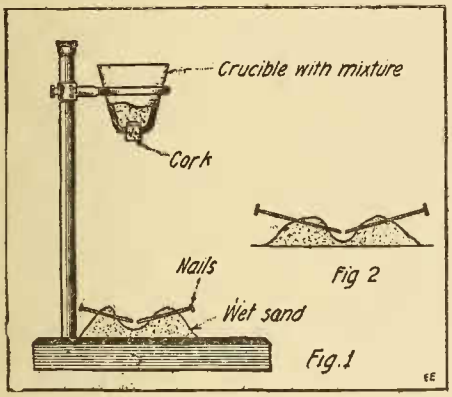
"Thermit" consists of a mixture of aluminum and the oxid of an element—usually a metal—to be reduced, as Fe_2O_3, MnO_2, SiO_2, etc. The aluminum has such intense affinity for oxygen that it reduces the oxides to their metals, giving a temperature of 3,000 deg. or over.

The equation of the following is:

$$Fe_2O_3 + 2Al = Al_2O_3 + 2Fe$$

Mix equal quantities of iron oxid and aluminum and place in a clay or sand crucible, through the bottom of which a ½ inch hole has been drilled, and the hole fitted with a cork. Support the crucible on a ring support or a ring stand, as shown in Fig. 1. Place some wet sand in a pan, and set about 6 inches under the crucible.

A small hole is made in the sand with the finger and two nails placed in it as shown in Fig. 2. They should just touch each other. A piece of magnesium ribbon is placed in the mixture in the crucible and ignited. As soon as the ribbon is lighted the cork should be removed with a pair of pliers. This must be done *quickly,* and the operator should *step aside* and avoid being burned by the spattering which is quite considerable. The molten mass will now pour into the hole in the sand and weld the nails together.



Do You Know What "Thermit" Is? This Experiment Will Get You Acquainted With It. One Use of It Is to Weld Street Car Rails.

PHARAOH'S SERPENTS' EGGS.

Take mercury and dissolve it in moderately diluted nitric acid by means of heat, take care, however, that there be always an excess of metallic mercury remaining; decant the solution and pour it in a solution of sulphocyanide of ammonia or potassium, which may be bought at a good drug store or of a dealer in chemicals; equal weights of both will answer; a precipitate will fall to the bottom of the beaker or jar, which is collected on a filter and washed two or three times with water, when it is put in a warm place to dry; take for every pound of this material 1 ounce of gum tragacanth which has been soaked in hot water; when the gum is completely softened it is to be transferred to a mortar, and the pulverized and dried precipitate gradually mixed with it by means of a little water, so as to present a somewhat dried pill mass, from which, by hand, pellets of the desired size are formed, put on a piece of glass, and dried again. They are then ready for use.

JAPANESE MATCHES.

(Scintellettes)—Lampblack 5 parts, sulphur 11 parts, gunpowder from 26 to 30 parts, this last proportion varying with the quality of the powder; grind very fine; make the material into a paste with alcohol, form it into dice about ¼ inch square with a knife as a spatula, let them dry rather gradually on a warm mantelpiece, not too near a fire; when dry fix one of the little squares into a cleft made at the end of a lavender stalk or, what is better, the straw-like material of which house carpet-brooms are made, light the material at a candle, holding the stem downward, after the first blazing off a ball of molten lava will form, from which the curious corruscations will soon appear.

Polishes and Stains.

POLISHES—15 KINDS.

Carvers' Polish.—White resin, 2 ozs.; seedlac, 2 ozs.; spirits of wine, 1 pt. Dissolve. It should be laid on warm. Avoid moisture and dampness when used.

French Polish.—Gum shellac, 1 oz.; gum arabic, ¼ oz.; gum copal, ¼ oz. Powder and sift through a piece of muslin; put them in a closely corked bottle with 1 pt. spirits of wine, in a very warm situation, shaking every day till the gums are dissolved; then strain through muslin, and cork for use.

Polish for Dark Colored Woods.—Seedlac, 1 oz.; gum guaiacum, 2 drs.; dragon's blood, 2 drs.; gum mastic, 2 drs.; put in a bottle with 1 pt. spirits of wine, cork close, expose to a moderate heat till the gums are dissolved; strain into a bottle for use, with ¼ gill of linseed oil; shake together.

Waterproof Polish.—Gum benjamin, 2 ozs.; gum sandarac, ¾ oz.; gum anima, ¼ oz.; spirits of wine, 1 pt.; mix in a closely stopped bottle, and place either in a sand bath or in hot water till the gums are dissolved, then strain off the mixture, shake it up with ¼ gill of the best clear poppy oil, and put it by for use.

Finishing Polish.—Gum shellac, 2 drs.; gum benjamin, 2 drs.; put into ½ pt. best rectified spirits of wine in a bottle closely corked; keep in warm place, shaking frequently till the gums are dissolved. When cold, shake up with it two teaspoonfuls of the best clear poppy oil.

Polish for Removing Stains, Spots and Mildew from Furniture.—Take of 98 per cent, alcohol, ½ pint; pulverized resin and gum shellac, of each, ¼ oz. Let these cut in the alcohol; then add linseed oil, ½ pt.; shake well, and apply with a sponge, brush, or cotton flannel, or an old newspaper, rubbing it well after the application, which gives a nice polish.

Polish for Reviving Old Furniture.—Take alcohol, 1½ ozs.; spirits of salts (muriatic acid), ½ oz.; linseed oil, 8 ozs.; best vinegar, ½ pt.; and butter of antimony, 1¼ oz.; putting in the vinegar last.

Jet Polish for Wood or Leather, Black, Red, or Blue.—Alcohol (98 per cent) 1 pt.; sealing wax, the color desired, 3 sticks; dissolve by heat, and have it warm when applied. A sponge is the best to apply it with.

Polish for Turners' Work.—Dissolve sandarac, 1 oz., in spirit of wine, ½ pt.; next shave beeswax, 1 oz.; and dissolve it in a sufficient quantity of spirits of turpentine to make it into a paste, add the former mixture by degrees to it, then with a woolen cloth apply it to the work while it is in motion in the lathe, and with a soft linen rag polish it. It will appear as if highly varnished.

Furniture Polish.—Beeswax, ½ lb., and ¼ of an oz. of alkanet root; melt together in a pipkin until the former is well colored. Then add linseed oil and spirits of turpentine, of each half a gill; strain through a piece of coarse muslin.

French Polishes.—1. Shellac, 3 lbs.; wood naphtha, 3 pts., dissolve. 2. Shellac, 2 lbs.; powdered mastic and sandarac, of each 1 oz.; copal varnish, ½ pint; spirits of wine, 1 gal. Digest in the cold till dissolved.

Black Walnut Polish.—Take pulverized asphaltum; put in a jar or bottle, pour over it about twice its bulk of turpentine or benzole, put in a warm place, and shake occasionally; when dissolved, strain and apply it to the wood with a cloth or stiff brush; should it prove too dark, dilute with turpentine or benzole. If desired to bring out the grain still more, apply a mixture of boiled oil and turpentine; this is better than oil alone. When the oil is dry the wood can be polished with the following: shellac varnish, 2 parts; boiled oil, 1 part; shake it well before using. Apply with a cloth, rubbing briskly.

POLISHES (Cont.)

To Polish Wood.—Take a piece of pumice-stone and water, and pass repeatedly over the work until the rising of the grain is cut down. Then take powdered tripoli and boiled linseed oil, and polish the work to a bright surface.

Clock Case and Picture Frame Finish.—Copal varnish, 2 lbs.; linseed oil varnish, ½ oz.; mix well, shake often, and place in a warm spot. The wood to be varnished is prepared with a thin coat of glue-water, and rubbed down with fine pumice-stone or something equivalent. In a light-colored wood, a light pigment, such as chalk, is added to the glue-water; in dark wood, a dark pigment is added. When ready, the articles are varnished with the above mixture, and, after drying, rubbed with a solution of wax in ether, thereby receiving a high polish.

White Polish for White Woods.—White bleached shellac, 3 ozs.; white gum benzoin, 1 oz.; gum sandarac, ½ oz.; spirits of wine or naphtha, 1 pt. Dissolve.

STAINS OF ALL KINDS.

The following formulas are used by many furniture manufacturers:

Walnut Stain.—Dissolve in 30 oz. of water 1 oz. permanganate of potash. Apply this solution twice. Wait a few minutes and wash with clean water. When dry oil and polish.

To Stain Pine a Walnut Color.—Mix thoroughly 1 pound burnt sienna, 1 pound dry burnt umber, and 4 oz. lamp black; add to 1 gallon of very thin shellac. Apply with a brush. When thoroughly dry rub down with fine sandpaper and then give one coat of shellac or varnish.

Walnut Stain for Hard Wood.—To 1 gallon of strong vinegar add 1 pound dry burnt umber, ½ oz. rose pink, and ½ pound dry burnt Vandyke brown. Mix thoroughly and apply with a brush.

WALNUT STAIN FOR CABINETS.

The following stain is excellently adapted to the finishing of wireless and electrical cabinets and instruments, and for various other wooden articles on which it is desired to have a uniform coloring or finish.

Prepare a solution of: 6 ounces of a solution of potassium permanganate, and 6 ounces of sulfate of magnesia in 2 quarts of hot water. The solution is applied with a brush and the application should be repeated. In contact with wood the potassium permanganate decomposes, and a lasting walnut color results. If small pieces of wood are to be thus stained, a very dilute bath is prepared according to the above description, then the wooden pieces are immersed and left in the solution for from 1 to 5 minutes, according to whether a lighter or darker color is desired.

The intense black color that cabinetmakers produce is obtained by moistening the wood with dilute sulfuric acid and afterwards gently heating. The following mixture answers well. Sulfuric acid, one ounce, water, 8 ounces. When cold add sugar in the proportion of 1 ounce to ten fluid ounces.

Deep brown on oak can be obtained by giving the wood a coat of iron chloride and when dry a coat of ammonium sulfide. This is darkened with tannic acid.

Analine mahogany—One-half ounce Bismark brown in three pints of boiling water. This is darkened with tannic acid.

Chinese Brown Mahogany—Boil logwood chips in twice their bulk of water, for two hours; strain and add a small quantity of chlorid of tin.

Vandyke brown 1 oz., burnt umber, ¾ oz., aqua ammonia, 4 oz. Mix in open air to avoid fumes, strain and apply.

To brighten stain—Nitric acid ½ oz., hydrochloric acid ½ oz., rain water 1 oz. Mix several days before using.

Brown-Black—Logwood powder 1 oz., iron sulfate 1 oz. Apply separately in washes in order named.

Finishing Wax.—1 lb. best beeswax, 2 lbs. turpentine. Place in a vessel and heat separately. Do not place over a fire.

Metal Varnish—One part copal, 1 part oil of rosemary, in 2 or 3 pints of absolute alcohol. This should be applied while hot.

Polish—One pint boiled oil, 4 oz. vinegar, 2 oz. spirits of camphor, 1 oz. ammonia, ½ oz. antimony. Shake and let stand 2 or 3 days before using.

REMOVING STAINS OF ALL KINDS.

Solution No. 1. 20% solution of acetic acid or tartaric acid.

Solution No. 2. Five grams of bleaching powder (CaClO). Boil in 100 c.c. of water until a pink color appears. Filter and add 50 c.c. of cold water.

To remove ink, coffee, tea, fruit, and dye stains, wet the spot thoroughly with No. 1. Absorb the superfluous liquid with a blotter and apply No. 2. Rinse and repeat if necessary.

For removing common stains, treat as shown in the following table:

STAIN	REMOVED BY
Acids	Cold water, Nos. 1 and 2.
Grass and fruit	Cold water, alcohol, Nos. 1 and 2.
Grease	Gasoline, carbon tetrachlorid, chloroform, ether, carbon bisulfid, ammonia, soap-suds, warm fullers earth (cover with a blotter and apply a warm iron.)
Dyes, coal tar or of vegetable origin	Nos. 1 and 2, ammonia.
Mildew	Nos. 1 and 2, sunlight.
Inks	Nos. 1 and 2.
Inks, indelible (silver).	Potassium cyanid, 10%. Use great caution—intensely POISONOUS, Sodium hyposulfite 20% solution.
Iodin	Methyl alcohol, potassium iodid Sol. 10%.
Iron Rust	Warm oxalic or citric acid, 10%. If in silk, let it alone.
Paint, varnish	Turpentine, benzine, carbon tetrachlorid. Use no turpentine on silk.
Tar, wagon grease	Soap and oil, turpentine.

STOVE POLISH.

Black Lead, 5 parts; Bone Black, 5 parts; Iron Sulfate, 10 parts. Mix thoroughly and make into a paste with water.

REMOVING ACID STAINS.

If first aid is given to acid-stained cloth, one may often remove the stain without taking the trouble to neutralize the acid; the removing agent is merely chloroform. If, however, the cloth has been plainly injured or destroyed by the acid, strong ammonia should first be used to neutralize.

In the case of hydrochloric or sulfuric acid, concentrated ammonia alone will be sufficient. But beware of cheap dyes! Ammonia will turn a pair of black-striped beach trousers into black trousers. In such a case, chloroform will also remove the running dye.

POLISH FOR VARNISHING WOOD.

Shake well together 1 pint *Vinegar,* 1 oz. *Alcohol,* 1 pint *Linseed Oil,* 1 oz. *Butter of Antimony.*

ROSEWOOD STAIN.

Alcohol 1 gallon, camwood 2 ounces. Set in a warm place 24 hours. Add extract of logwood 3 ounces, aqua fortis 1 ounce. When dissolved it is ready for use.

A BRIGHT POLISHER.

A few grains of butter of antimony added to a bottle of ordinary machine-oil proves to be an excellent polisher for old furniture. It is easily made and brightens wherever applied to.

WOOD STAINS.

To stain ebony, mix: Solution A—Water, 10 ounces; sulphuric acid, 1 ounce. Brush on and allow to sink into the wood to be stained, and then hold close to a fire

for a few minutes, in which time a rich black is produced.

Solution B—Strong solution of aniline in alcohol or French polish.

To Stain Walnut.—Potassium permanganate, 60 grains; water, 10 ounces. Used weaker it imitates oak.

To Stain Green.—Solution A—Verdigris, 4 ounces; vinegar, 40 ounces. Solution B—Indigo, 1 drachm; vinegar, 20 ounces. Boil each for 10 minutes. Mix according to tint. Average proportion: (A) 6 ounces: (B) 1 ounce.

Varnishes and Paints.

VARNISHES.

Varnishes (common Oil Varnish).—*Resin,* 4 *lbs.; Beeswax,* ½ lb.; *Boiled Oil,* 1 gal. Mix with heat, then add *Spirits of Turpentine,* 2 quarts.

Chinese Varnish.—Mastic, 2 oz.; *Sandarac,* 2 oz.; *Rectified Spirits,* 1 pt. Close the Matrass with bladder with a pin hole for the escape of vapor; heat to boiling in a sand or water bath, and when dissolved strain through linen.

Mastic Varnish.—Mastic, 1 lb.; *White Wax,* 1 oz.; *Spirits of Turpentine,* 1 gal. Reduce the gum small, then digest it with heat in a closed vessel till dissolved.

Turpentine Varnish.—Resin, 1 lb.; *Boiled Oil,* 1 lb. Melt, then add *Turpentine* 2 lbs. Mix well.

Pale Varnish.—Pale African Copal, 1 part; fuse. Then add hot *Pale Oil,* 2 parts. Boil the mixture till it is stringy; then cool a little, and add *Spirits of Turpentine,* 3 parts.

Lacquer Varnish.—A good lacquer is made by coloring *Lac Varnish* with *Turmeric* and *Annatto.* Add as much of these two coloring substances to the varnish as will give the proper color; then squeeze the varnish through a cotton cloth, when it forms lacquer.

Gold Varnish.—Digest *Shellac,* 16 parts; *Gum Sandarac, Mastic,* of each 3 parts; *Crocus,* 1 part; *Gum Gamboge,* 2 parts; all bruised, with *Alcohol,* 144 parts. If yellow is required, use *Turmeric, Aloes, Saffron* or *Gamboge;* for red, use *Annatto* or *Dragon's Blood* to color. *Turmeric, Gamboge* and *Dragon's Blood* generally afford a sufficient range of colors.

Varnish for Tools.—Take Tallow, 2 oz.; *Resin,* 1 oz., and melt together. Strain while hot to get rid of specks which are in the resin; apply a slight coat on your tools with a brush, and it will keep off rust for any length of time.

Cabinet-Maker's Varnish.—Very pale *Shellac,* 5 lbs.; *Mastic,* 7 oz.; *Alcohol,* 90 per cent, 5 or 6 pts. Dissolve in the cold with frequent stirring. Used for French polishing, etc.

Waterproof Varnish.—The following is much used for waterproof textile fabrics: Boil together until thoroughly incorporated: 2 qts. *Linseed Oil* and ½ lb. *Flour of Sulphur.* Apply lukewarm.

Electrical Varnish.—The only good varnish for all kinds of electrical work, also for finishing wood and metal work, is formed by dissolving *Orange Shellac* in 95 per cent. *Alcohol.*

Mechanics Varnish.—Mix together: 5 parts of *Rosin,* 1 part of *Dragon's Blood,* 1 part of *Gamboge,* 2 parts of *Gutta Percha,* 1 part of *Shellac,* 50 parts of *Volatile Tar Oil.*

INSULATING VARNISH.

White shellac 4 ounces, black aniline dye 1 tablespoonful. The aniline dye must be soluble in alcohol only. This mixture, if correctly made, when laid on with a soft brush will produce a shiny black surface, giving the instrument a neat appearance. It must be laid on quickly, as it sets in a few seconds.

PAINTS.

Proportions of Colors for Ordinary Paints:

White—100 parts of *White Lead.*

Black—100 parts of *Lampblack.*

Green—25 parts of *White Lead* and 75 parts of *Verdigris.*

Stone—99 parts of *White Lead* and 1 part *Burnt Umber.*

Lead—98 parts of *White Lead* and 2 parts of *Lampblack.*

Red—50 parts of *Red Lead and* 50 parts of *Red Ocher.*

Chocolate—4 parts of *Lampblack* and 95 parts of *Spanish Brown.*

Add the required quantity of *Raw Linseed Oil, Boiled Linseed Oil, Turpentine* and *Drier.*

For 20 lbs. of paint take 2 lbs. of *Raw Linseed Oil,* 2 lbs. of *Boiled Linseed Oil,* ½ lb. of *Turpentine,* 1-10 lb. of *Drier.*

The proportions given must only be taken as an approximate guide when the materials are of good quality.

Anti-Corrosive Paint.—Take equal parts (by weight) of *Whiting* and *White Lead,* with half the quantity of *Fine Sand* or *Gravel,* with a sufficient quantity of *Color.* This paint can be used as a water color, but it is more durable to dry it in cakes or powder after mixing, and then use it as an oil paint by grinding it again in linseed oil. The proportions are: 12 parts of *Raw Linseed Oil;* 1 part *Boiled Linseed Oil* and 3 parts of *Sulphate of Lime* well mixed; 1 gal. of this prepared oil is used to 7 lbs. of the powder.

Luminous Paint.—Mix together 40 parts of *Copal Varnish* (containing neither lead nor manganese, which would destroy the phosphorescence); 6 parts of prepared *Barium Sulphate;* 6 parts of prepared *Calcium Carbonate;* 12 parts of prepared *White Zinc Sulphite;* 36 parts of good *Luminous Calcium Sulphite* in a proper vessel to an emulsion and then grind it very fine in a color mill.

Phosphorescent Paint.—Heat *Strontium Thisulphate* for 15 minutes over a good Bunsen gas lamp, and then for 5 minutes over a blast lamp. Mix with pure *Melted Paraffin* for use as a paint for clock dials, etc., and expose for a time to sunlight.

Stencil Paint.—Take *Shellac,* 2 oz.; *Borax,* 2 oz.; *Water,* 25 oz.; *Gum Arabic,* 2 oz.; *Lampblack,* sufficient quantity. Boil the borax and shellac in water till they are dissolved; when the solution has become cold, complete 25 oz. with water and add lampblack enough to bring the preparation to a suitable consistence.

Innoxious Color for Painting Toys.—Mix 6 parts of *White Fine Chalk,* 3 parts of *Calcined Magnesia* (thoroughly calcined). Add a few drops of indigo solution. Oil, turpentine, driers, as for any other paint.

White Paint for Metallic Surfaces.—Oil paints used on metallic surfaces exposed to heat frequently turn yellow. If, instead of oil, *Sodium Silicate* be used, no change of color will be noticed.

Marine Paint.—For metals in salt water: 44 parts of *Red Lead,* 24 parts of *Quicksilver,* 5½ parts of *Thick Turpentine.* Mix to proper consistency with boiled linseed oil. Grind the turpentine and quicksilver together. Then grind this mixture with the *Red Lead.*

LUMINOUS PAINTS, RED, BLUE AND GREEN.

Orange—46 parts of varnish are mixed with 17.5 parts prepared barium sulphate, 1 part prepared India yellow, 1.5 parts prepared madder lake and 38 parts of luminous calcium sulphide.

Green—48 parts of varnish, 10 parts prepared barium sulphate, 8 parts green chromic oxide and 34 parts luminous calcium sulphide.

Blue—42 parts of varnish, 10.2 parts prepared barium sulphate, 6.4 parts ultramarine blue, 5.4 parts cobalt blue and 46 parts luminous calcium sulphide.

Luminous colors for artists' use are prepared by using pure East India poppy oil, in same quantity, instead of the varnish, and taking pains to grind the materials as fine as possible.

FOR CLEANING VARIOUS SUBSTANCES.

Alabaster.—Use strong soap and water.

Black Silk.—Brush and wipe it thoroughly, lay on table with side intended to show, up; sponge with hot coffee strained through muslin; when partly dry, iron.

To Remove Stains or Grease from Oil Paint.—Use bisulfid of carbon, spirits of turpentine, or if dry and old, use chloroform. These and tar spots can be softened with olive oil and lard.

Stains, Iron Rust, or Ink from Vellum or Parchment.—Moisten the spot with a solution of oxalic acid. Absorb same quickly by blotting paper or cloth.

Rust from Steel.—Take half ounce of emery powder with one ounce of soap and rub well.

Fruit Spots from Cotton.—Apply cold soap, then touch the spot with a hair pencil or feather dipped in chlorate of soda, then dip immediately in cold water.

Grease from Silks.—Take a lump of magnesia, rub it wet on the spot, let it dry, then brush the powder off.

Iron Rust may be removed from white goods by sour milk.

Scorch Stains from White Linen.—Lay in bright sun.

Mildew.—Moisten the spot with clean water; rub on it a thick coating of castile soap mixed with chalk scrapings; rub with end of finger, then wash off.

Oil Marks on Wall Paper.—Apply paste of cold water and pipe clay, leave it on all night, brush off in the morning.

Paint Spots from Clothing.—Saturate with equal parts turpentine and spirits of ammonia.

To Cleanse House Paper.—Rub with a flannel cloth dipped in oatmeal.

Black Cloth.—Mix one part of spirits of ammonia with three parts of warm water, rub with sponge or dark cloth, clean with water, rub with the nap.

Furniture, for Finger Marks.—Rub with a soft rag and sweet oil.

Chromos.—Go over lightly with a damp linen cloth.

Zinc.—Rub with a piece of cotton cloth dipped in kerosene, afterwards with a dry cloth.

Hands from Vegetable Stains.—Rub with a slice of raw potato.

Window Glass.—Paint can be removed by a strong solution of soda.

To Clean Tinware.—Common soda applied with a moistened newspaper and polished with a dry piece, will make it look like new.

CLEANING COMPOUND.

Mix 1 ounce of borax and 1 ounce gum camphor with 1 quart boiling water; when cool add 1 pint of alcohol, bottle and cork tightly. When wanted for use, shake well and sponge the article to be cleaned. This is an excellent mixture for cleaning soiled black cashmere and woolen dresses, coat collars and black felt hats.

Woodcraft.

TO PETRIFY WOOD.

Equal quantities of gem salt, rock alum, white vinegar, chalk and Pebbles' powder. This solution will petrify wood or any other porous substance if put in after the ebullition is over.

A Stone Coating for Wood: Forty parts chalk, fifty of resin, four of linseed oil, melted together; to this should be added one part of oxid of copper and then one part of sulfuric acid. This last should be added very carefully. Apply with a brush while hot.

To Imitate Dark Woods: The appearance of walnut may be given to white woods by painting or sponging with a concentrated warm solution of permanganat of potash. The effect varies for different kinds of woods, some becoming stained rapidly, others requiring more time. When stained wash thoroughly with soft water. After the wood has dried it may be varnished, and will be found to very closely resemble the natural dark woods.

To Polish Wood: Only a very few experimenters who make their own cabinets know how to put a good polish on their woodwork. The following is a very good method. Take a piece of pumice stone and water, and pass regularly over the work until the rising of the grain is cut down; then take tripoli and boiled linseed oil, and polish to a bright surface.

FILLER FOR WOOD.

Equal parts Japan, boiled linseed oil and turpentine, and one-half that quantity of dry starch. Mix and apply with sponge or flannel. Dry 48 hours and apply with No. 0 sandpaper. Make second application and when dry rub with ticking over a block of wood until the wood is perfectly smooth. Stain and finish up in any desired style. Use no color for oak.

WOOD POLISHES.

A polish for burnished wood surfaces may be made of the following: *Wood Pulp,* 40 parts; *Hydrochloric Acid,* 44 parts; *Chloride of Lime,* 15½ parts; *Turpentine,* ½ part. Mix in the form of a paste and smear over the surface, allowing it to remain a short time and remove it by quick strokes of a soft brush or leather, thoroly cleaning the surface. Rub gently to a polish with a fresh piece of cloth or chamois.

For very highly polished surfaces the following may be used: Dissolve 5 parts *Potassium Carbonate* in 300 parts *Water;* dissolve in this 500 parts shaved-up *Beeswax* by boiling until the wax is partially saponified, replacing the water evaporated. Remove from the fire and stir until cold; add *Oil of Turpentine,* 800 parts, stir constantly until a smooth emulsion results, then add 800 parts of *Distilled Water,* continuing the stirring. Wash, rinse and dry the surface to be polished. Apply the paste as uniformly and as thinly as possible; rub off with a soft woolen cloth.

ACID PROOF TABLE TOPS.

The following solutions render a table top impervious to the action of acids and alkalies.

Solution No. 1:

Iron Sulfate	2 parts
Copper Sulfate	2 "
Pot. Permanganate	4 "
Water	50 "

Solution No. 2:

Aniline	6 "
Hydrochloric acid	9 "
Water	50 "

Two coats of solution No. 1 are applied with a brush—the second coat being applied after the first has dried. The surplus of the second coat is removed by rubbing, after which solution No. 2 is applied in two coats. When thoroughly dry, a coat of raw linseed oil is to be rubbed well into the wood with a cloth impregnated with it.

HOW TO PUT A PIANO FINISH ON WOOD.

If the wireless man wishes to finish his instruments or table with a finish which will not only last indefinitely, but closely rival the finish on his piano, the following process must be closely adhered to. The method described below is that which the manufacturers of fine pianos use.

1. Sandpaper the wood thoroughly with fine sandpaper. Do not sandpaper across the grain.

2. Use oil stain or dye. Put on heavy and wipe off surplus.

3. Next put on a good wood filler. Rub filler into the wood with excelsior. The pores of the wood should all be filled. Rub across the grain.

4. Sandpaper very lightly.

5. Give three coats of shellac. Thin white shellac is preferable. Sandpaper each coat when the shellac is dry before applying the next coat.

6. After the last coat of shellac is sandpapered apply a coat of the very best grade of varnish obtainable. Sandpaper this coat when dry.

7. Apply another coat of varnish. When *thoroughly dry* rub with *coarse pumice* stone. The pumice stone is put on *wet felt* and rubbed hard until the wood is entirely free from lumps and perfectly smooth. Wipe off all traces of the pumice stone with a wet rag or chamois skin.

8. Give the last coat of varnish.

9. Rub with *fine* pumice stone in the same manner as with the coarse, but do not rub as hard or as long. Rub just hard enough to take off any lumps which the varnish might have left. Wipe off any of the pumice stone remaining.

10. Rub with rotten stone in the same manner; that is, very lightly. Rotten stone is sold in small cakes about the size of your fist and is likewise applied with wet felt. Wipe the wood clean and let it dry.

11. Now rub with the palm of your hand. Rub hard until the wood is clear and smooth. You will now have a mirror-like finish. The wood becomes slippery after the hand rubbing and will not catch the dust.

In applying the varnish and shellac put on a thick coat roughly. Then use long sweeping strokes with a fine brush. Always wait until the varnish is dry before sandpapering. See that the varnish is always thin and plastic before applying.

RESTORING THE COLOR OF MAHOGANY.

Add ½ ounce of Alkanet root, cut small, to a pint of linseed oil and when this has stood for about 5 or 6 days add ½ ounce powdered gum arabic and 1 ounce of shellac varnish. Let this mixture stand near the fire for a week and then strain. Wash the mahogany well with soap and water, before polishing with this recipe. This recipe should be handy to experimenters for polishing the bases of their apparatus.

Mahogany Stain.—Dissolve Burnt Sienna in vinegar.

To make paper transparent.—By dipping the paper in fresh-distilled benzine, paper becomes transparent. This is handy for experimenters who desire to trace designs without using ordinary tracing paper. The paper becomes opaque as soon as the benzine evaporates and it will be necessary to moisten paper again. Ink will not run on its surface when damp.

SOLUTION FOR MAKING WORK TABLE IMPERVIOUS TO ACID AND ALKALI SOLUTIONS.

Doubtless, many experimenters, especially those working with the various chemical reagents, desire some coating for the work table that is impervious to both acid and alkali solutions. The following method has been used in the laboratory with decided success, and is heartily recommended to those who desire a similar formula.

Two solutions are to be made:

Solution 1. Iron sulfate, 4 parts; copper sulfate, 4 parts; potassium permanganate, 8 parts; water, 100 parts.

Solution 2. Aniline, 12 parts; hydrochloric acid, 18 parts; water, 100 parts, or aniline hydrochlorate, 15 parts; water, 100 parts.

Apply two coats of solution No. 1, while hot, applying the second coat as soon as the first has dried. After solution No. 1 has dried, the excess of solution which has dried upon the surface of the wood is thoroughly rubbed off before the application of solution No. 2.

Next, two coats of solution No. 2 are applied, and the wood permitted to dry thoroughly. The black color does not appear at once, but requires a few hours before turning to a rich ebony-black color. Later a coat of raw linseed oil is to be applied with a cloth.

The tables are cleaned very easily by washing with water or suds after any work is finished, and the application of another coat of oil puts them in excellent order for another experiment.

WOOD POLISHES.

1. The wood is first well smoothed with fine sandpaper, then covered with a thin coating of size from transparent glue, or thin shellac, to prevent the varnish from sinking into the wood. When dry, pour some varnish into a saucer, take a fine camel's hair brush, and commence to varnish at one corner, gradually spreading over the whole surface. Take care that there is not too much varnish on the brush, otherwise an even surface cannot be obtained. The first coating must be allowed to dry, which will take 2 or 3 hours; then sandpaper the surface smooth. This done, with great care spread the next coat of varnish, always using sandpaper when the surface does not turn out smooth.

The whole, when dry, may be rubbed well with a piece of warm woolen till bright and smooth. 2. To French polish, make the wood smooth; then pour some prepared polish into a saucer, and some linseed oil into another; take some pieces of woolen rag, and roll them up into a ball, covering them with a piece of linen drawn tightly over; the rags inside should first be saturated with the polish, and the whole should be taken in the fingers of the right hand in such a way that the linen may be drawn tightly over, and may present to the wood a smooth rounded surface. Polish with free, circular strokes, and gradually traverse the whole surface; apply now and then a drop of polish and a drop of oil to the surface of the rubber. When the grain of the wood disappears, allow it to stand 1 hour, or until hard, and then sandpaper the whole; repeat the polishing until smooth. If dull patches appear they may be removed by a few drops of spirits wine or a new rubber.

3. Dissolve, by heat, so much beeswax in spirits turpentine, that when cold it shall be thick as honey. This may be applied to furniture or to work running in the lathe, by means of a piece of clean cloth, and as much as possible should then be rubbed off by means of a clean flannel. Beeswax alone is often used; upon furniture it must be melted by means of a warm flat-iron; but it may be applied to work in the lathe, by holding the wax against it until a portion of it adheres; a piece of woolen cloth should then be held upon it, and the lathe turned quickly, so as to melt the wax; the superfluous portion may be removed by a small piece of wood, when a light touch with a clean part of the cloth will give it a gloss. A good polish may be given to mahogany by rubbing it with linseed oil, and then holding against it a cloth dipped in fine brick dust.

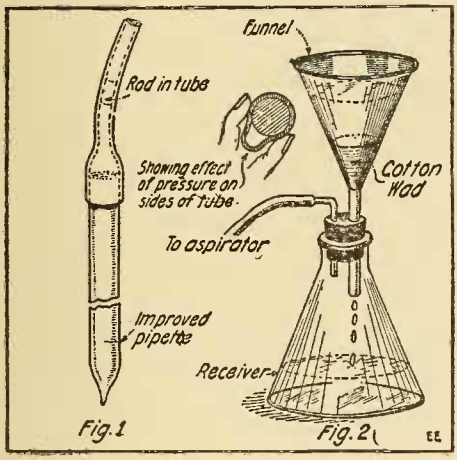
4. (Dark.) Seed lac 1 ounce, gum guaiacum, dragon's blood, and gum mastic, of each 2 drams. Put in a bottle with 1 pint spirits wine; cork close; expose to a moderate heat till dissolved; strain into a bottle for use, with ¼ gill linseed oil; shake together.

5. Take a piece of smooth pumice stone and water and pass repeatedly over the work till the rising of the grain is cut down; then take powdered tripoli and boiled linseed oil, and polish bright.

Laboratory Hints and Experiments (Chemical).

PRACTICAL CHEMICAL LABORATORY DEVICES.

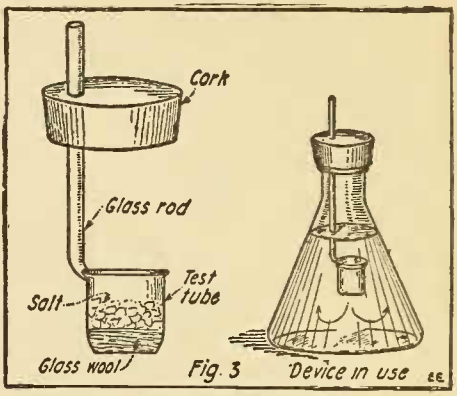
There are many instruments and operations in chemistry that can be so improved as to make them handier or to shorten the time required for a given process. Many of these are in everyday use in large laboratories but the experimenter hears but little of them.



Here Are a Home-made Burette-Pipette and a Vacuum-Filter of Simple and Ingenious Construction Welcome in Every Laboratory.

A form of burette, or more properly a pipette, having several advantages is shown in Fig. 1. Instead of the usual form with the stop-cock at the bottom, a plain graduated tube is fitted at the top with a 6-inch length of rubber tubing. The valve in this case is made by sliding a short length of glass rod into the rubber tube, locating the same midway of its length. The tube is normally kept closed by this rod but a slight pressure on one side of the rubber will cause the tube to buckle out and form a channel through which liquids or air can flow.

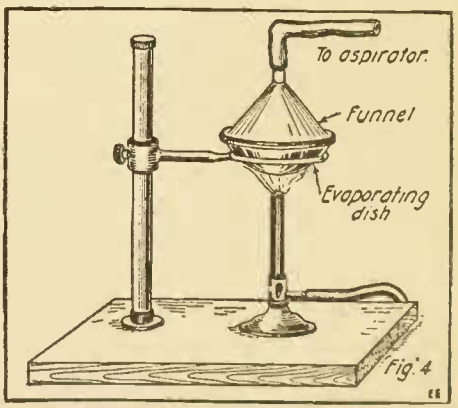
The device can be filled either by sucking the fluid up into the tube with the mouth or by immersing it into the fluid with the valve open and removing after the valve is closed. This valve will give a finer regulation of the discharge than the usual stop-cock, a drop



An Automatic Saturator Is Easily Made as Shown in Above Diagram and May Come in Handy.

at a time or a steady stream being readily attainable.

VACUUM FILTER: When filtering thick fluids the process may be speeded up by the use of a vacuum filtering device. To create the vacuum, use can be made of the glass aspirators which are procurable at a very



This Suggestion to Get Rid of All Obnoxious Fumes in the Small Laboratory Is Certainly Meritorious and Shows What a Little Ingenuity Will Attain.

reasonable price. To use this for filtering, the receiver is fitted with a cork having two holes. One, large enough to take the spout of the funnel, the other having a short glass tube inserted. See Fig. 2.

A wad of absorbent cotton is placed in the bottom of the funnel and reaching a short distance up the sides. This is to support the filter paper and prevent it breaking under air pressure. The bent glass tube is connected to the aspirator and when the water flow is started a slight vacuum will exist in the receiver. Any liquid poured into the funnel will be filtered at a rapid rate due to the air pressure forcing it through.

Saturated Solution Apparatus.

Saturated solutions of salts can be more quickly made by supporting the salt near the surface of the liquid. The idea being that as the salt dissolves the fluid gets heavier and sinks to the bottom, being replaced by other fluid. This circulation is automatic and continues till the saturation point is reached.

A little device, easily made of glass, that can be used with all chemicals is shown in Fig. 3. The body is made by cutting a two inch length from a large test tube and bending in the edges at the cut by heating till soft in a Bunsen flame. A wad of glass wool is placed in the tube, being held in place by the turned-in edge. The glass rod used to support the device is fastened in place by heating the rod and tube where they are to be joined until soft and then pressing them together. A cork fitted over the rod will support the device inside a bottle.

In use the tube is filled with the salt to be dissolved and placed in the bottle containing the solvent at such a height that the top of the tube is just below the surface. Additional salts may be added from time to time as found necessary.

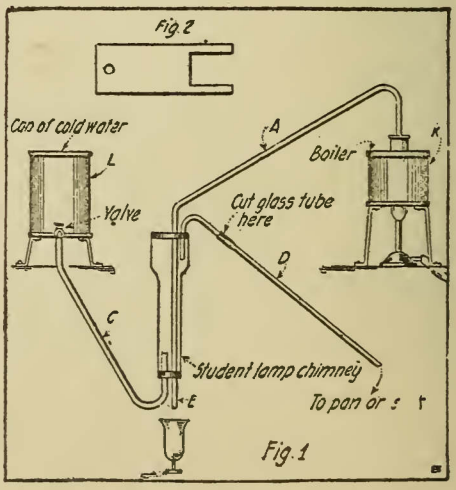
The aspirator mentioned in connection with filtering can be used with advantage when drying or evaporating. In this case the evaporating dish is covered by a funnel the spout of which is connected to the suction tube of the aspirator; see Fig. 4. The vacuum created will draw off all fumes and vapors at a rapid rate. Should the vapor be required for further experiment a condenser can be connected in the line between the funnel and the aspirator to condense the vapor.

AN INTERESTING CHEMICAL EXPERIMENT.

Dissolve a little cobalt chlorid in some aque regia (by heating). The mixture will be green. Add a few drops of water and it will turn red. Add three times as much water as mixture and use for invisible ink; when heated it will turn blue.

HOME-MADE DISTILLING APPARATUS.

The accompanying sketch illustrates a home-made Distilling Apparatus. The condenser is made from a student lamp chimney. Insert a cork at both ends and bore them for glass tubing. Tube A should extend straight through the condenser; tube D should extend about an inch below the



Easily Made Distilling Apparatus Which Every Amateur Chemist Will Find Extremely Useful About the Laboratory.

cork. I found that if tube D is cut off about four inches below the bend and a long piece of rubber tubing used instead of a long glass one it would cost less and be more serviceable. Tube C should extend about 1 inch above the bottom cork. The condenser is held in place by a piece of wood, shaped as in Fig. 2, fastened on a shelf above the bench.

The boiler K is an empty coffee can. A hole is cut in the cover and the neck of an empty maple syrup can is soldered over it. The cover is then soldered on the can so that the steam cannot escape. Three pieces of tin are next soldered on to form a support.

Another can L is fitted with a small faucet which can be obtained from an old gas jet. This can is supported on legs like the boiler. Care should be taken that the bottom of the can L is on a level or higher than the top of the condenser.

When the water boils in can K, the steam passes through tube A. The faucet on can L is turned on; *cold* water flows through tube C and circulates through the condenser and flows out through tube D into a sink or a large pan. The distillate is caught at E.

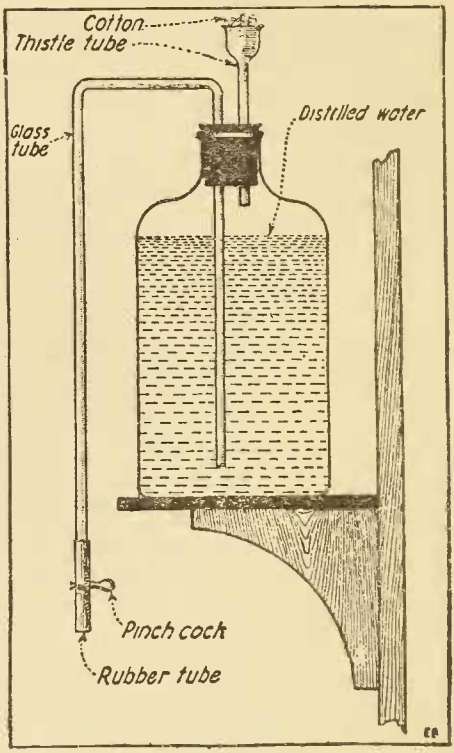
If, when the water is turned on, the lower cork leaks some melted paraffin should be poured slowly into the tube and allowed to harden. This may be done on both sides of the lower cork.

If anything besides water is to be distilled a glass flask must be used instead of can K.

HANDY DISTILLED WATER SUPPLY.

The accompanying drawing shows a convenient method for having a handy supply of distilled water. When it is once started siphoning through the bent tube, it will always be ready. Any amount can be drawn at will.

The thistle tube permits the air to enter the container, while the cotton in it keeps the dust, etc., from getting into the water. The drawing explains fully the construction.



Here Is a Very Handy Distilled Water Supply Acting on the Siphon Principle.

CHEMICAL BAROMETER.

To make a chemical barometer take potassium nitrate, 30 grs.; ammonium chloride, 30 grs.; camphor, 120 grs.; alcohol, 2 ozs. Put the mixture in a bottle ten inches long and ¾ inch in diameter. Cover the bottle with a piece of perforated plaster. If fine weather is indicated the insoluble matter will settle at the bottom of the bottle; previous to a change for rain the compound gradually raises, the fluid remaining transparent.

Twenty-four hours before a storm or very high wind the substance will be partly on the surface, the fluid being turbid and in a state resembling fermentation.

STORM GLASS OR BAROSCOPE.

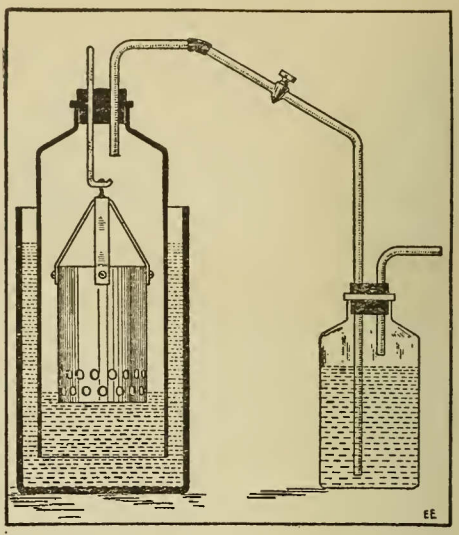
Potassium nitrat	Gr. 30
Ammonium chlorid	Gr. 36
Absolute alcohol	Fl. Dr. 6
Alcohol	Fl. Dr. 6

Put the mixture into a bottle 18 inches in length and ¾ inch in diameter, and cover the mouth with a piece of perforated plaster.

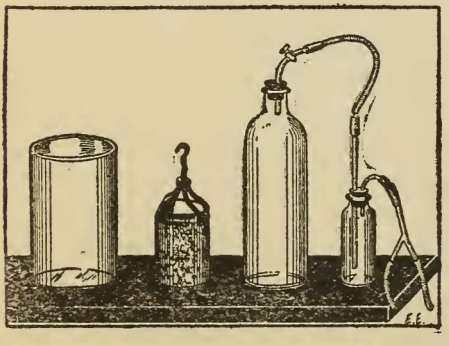
If the weather is to be fair the insoluble matter will settle at the bottom of the tube, while the liquid remains pellucid; but previous to a change for rain, the compound will gradually rise, the fluid remaining transparent. Twenty-four hours before a storm or very high wind the substance will be partly on the surface of the liquid, apparently in the form of a leaf; the fluid in such cases will be very turbid and in a state resembling fermentation.

A SIMPLY CONSTRUCTED GAS GENERATOR.

Among the automatic gas generators on the market there are few within reach of the average experimenter. To meet this condition, Prof. C. D. Dilts has recently developed a generator which may be easily and cheaply constructed. In experimenting with qualitative analysis a constant supply of hydrogen sulfide is essential. This generator, being self-regulating, will furnish a constant flow of hydrogen sulfide, carbon dioxid, or hydrogen. The principle of operation is the same as that of the well-known Kipp generator, namely that when the gas formed is not allowed to escape the solid material is automatically raised out of the liquid, but when the pressure is relieved the solid substance is lowered into the liquid, and the generator begins to function. As will be seen in the drawing, the four parts are: first, a glass jar or container; second, a bottle of slightly smaller diameter, with the bottom removed, and fitted with a stopcock in the top; third, a lead basket for holding the solid material; and fourth, a small wash bottle.

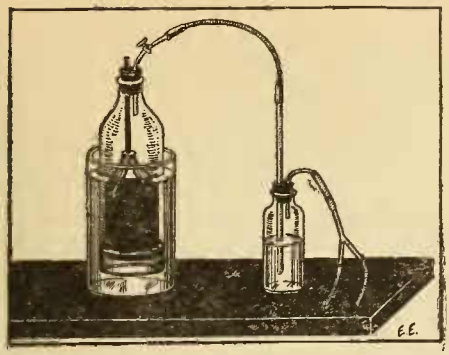


Sectional View of Gas Generator.



This Illustration Shows the Different Parts Composing the "Gas Generator" Here Described.

The glass jar may be easily made by cutting off the top of a large bottle. There are many methods which may be employed



Completely Assembled Gas Generator and Wash Bottle.

in removing the bell of the bottle, but by far the best and surest is the one described below.

Several long strips of newspaper, about an inch wide, should be soaked in water and wound about the bottle in two bands at the place where it is desired to break the bottle. About a quarter of an inch should be left between the two bands. The bottle should then be slowly revolved with the hands, allowing a blow-pipe flame to play upon the exposed part between the bands. When this portion is heated sufficiently the application of a drop of water will cause the glass to be evenly broken. The edges should then be smoothed on a soft grindstone. The bottom of the smaller bottle is removed in the same manner.

The sheet lead for the basket may be procured at any plumbing shop. It may be easily bent to the required shape, leaving small holes in the bottom to allow the acid to enter. The basket is suspended by means of a closed piece of glass tubing, bent to form a hook, which runs through the two-hole stopper. The delivery tube from the bottle may be fitted either with a glass stop-cock or with rubber tubing and metal pinch-cock. Altho not absolutely necessary, a wash bottle is a desirable addition to the generator, as it not only steadies the flow but cleans and purifies the gas.

The apparatus should now be assembled as is illustrated in the drawing and photograph. The solid material, such as iron sulfid (when H_2S is desired) is placed in the lead basket and the dilute acid in the glass jar. When the smaller bottle is placed in the jar the acid, reacting with the iron sulfid, engenders a flow of H_2S which forces the acid out of the basket if the stop-cock is closed. When the stop-cock is opened, the gas escapes and allows the acid to touch the iron sulfid, again causing the formation of H_2S. Thus gas is always easily procurable without waste of material.

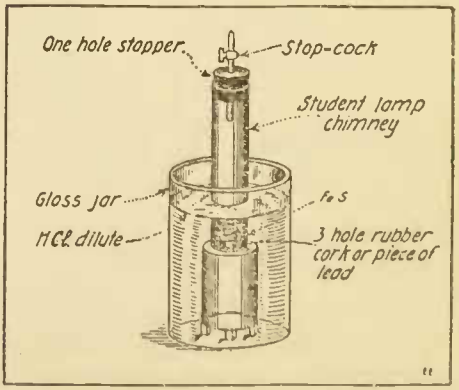
A RELIABLE HYDROGEN SULFID GENERATOR.

Herewith is a plan and description of a simple and cheap hydrogen sulfid generator.

This hydrogen sulfid generator has given very satisfactory service to the author. It can also be used for generating hydrogen, carbon dioxid, etc.

The necessary parts are:

1. Student lamp chimney.
2. Glass or porcelain jar (a large fruit jar will do).
3. Glass stop cock.



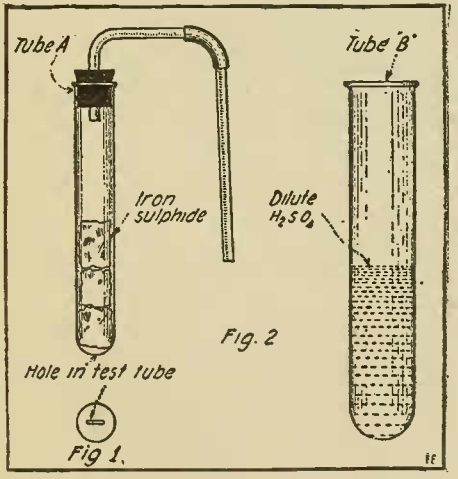
A Simple Yet Reliable Hydrogen Sulfid Generator Made From a Few Odd Pieces of Apparatus to Be Found About the Laboratory.

4. Rubber stoppers, three hole and one hole.
5. Iron sulfid (FeS).
6. Hydrochloric acid (HCl).

A SIMPLE GAS GENERATOR.

Frequently small quantities of gas are desired in the chemical laboratory, and no convenient and simple method of generation can be found. The apparatus described is very simple, yet it serves the purpose admirably.

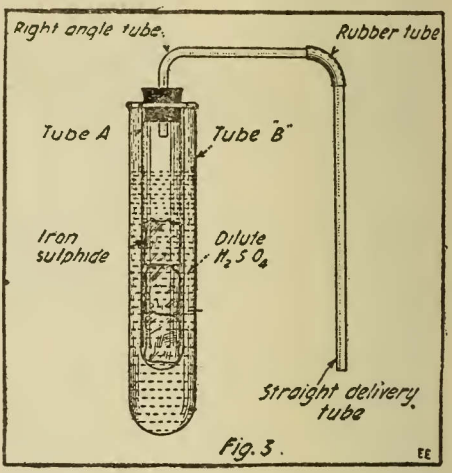
First, procure two test tubes, one having dimensions approximately 5/8" x 7" long, the other approximately 7/8" x 10" long. In the bottom of the smaller test tube file a small hole with a triangular file (Fig. 1), into this test tube fit a one-hole rubber stopper. Fit stopper, with a right angle, connecting tube, and straight delivery tube, as in Fig. 2, and insert in smaller test tube. The smaller tube A, is inserted in the tube B, the flare of tube A prevents it from slipping through to the bottom of tube B.



In Simplicity This Little Gas Generator Is Undoubtedly Unrivalled. Two Test-Tubes, a Cork, Some Rubber and Glass Tubing—That's All.

In operating: If H_2S is to be generated, a stick of FeS, iron sulfid is placed in tube A, and the cork inserted. Diluted sulfuric acid is put into tube B, filling it about two-thirds full. When tube A is inserted into tube B, a large volume of gas is produced.

If hydrogen is wanted, small clippings of iron or iron filings are put into tube A,



The Gas Generator Ready Assembled for Business.

and lowered into the dilute acid in B. Removing tube A stops the generation of gas.

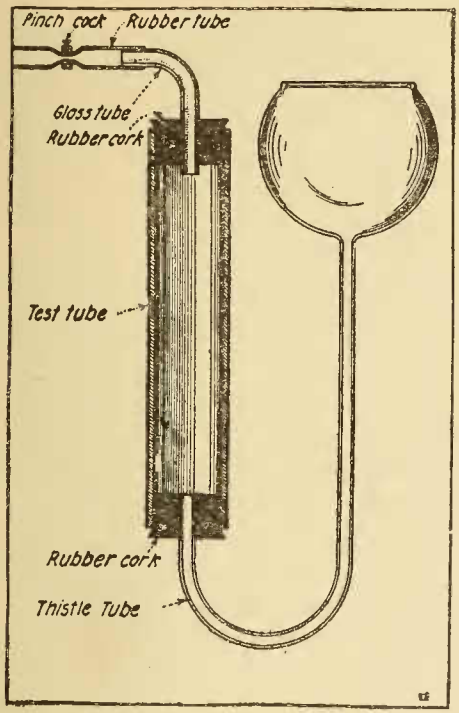
If carbon dioxid is to be generated, fill tube A with marble chips and tube B with dilute hydrochloric acid.

It is evident that the parts of the generator can be easily cleaned and new chemicals put in. The completed apparatus is shown in Fig. 3.

A SIMPLE KIPP GENERATOR.

The Kipp generator shown in the accompanying drawings can be easily and cheaply constructed. The drawing explains itself, so far as construction is concerned. The test tube should be as large as possible, but one 6" by 3/4" will do very well. The best way to cut the end off the test tube is to encircle it with a file scratch, wind two strips of wet filter paper around it 1/16" from the mark, and then heat the tube between the strips, when it will crack cleanly.

Such an apparatus, which will deliver a stream of gas at any time, is a great convenience and time-saver in almost any ex-



Simple Kipp Gas Generator, Made from Section of Test Tube, a Bent Thistle Tube and Two Rubber Corks.

perimenter's laboratory. For generating: Hydrogen, chlorin, carbon dioxid, or hydrogen sulfide, use: Dilute hydrochloric acid (1 : 3) in the thistle tube and granulated zinc, potassium permanganate, marble chips or iron sulfide respectively in the test tube.

A PRACTICAL HYDROGEN SULFID GENERATOR FOR THE CHEMIST.

Hydrogen sulfid is an absolute necessity in every laboratory where analysis is carried out, but, as this gas is quite poisonous and, furthermore, possesses a characteristic, disagreeable odor, it is essential that it be generated at the time of using.

Below is described a simple generator of my own design, which, from my experience, has proved a complete success. As will be seen, the action is essentially the same as in the well-known "Kipp," but, as the construction of this differs somewhat from my own design, I have found it necessary to add certain additional parts.

The materials needed are:

1 Wide mouth glass bottle G.

1 Gas cylinder.

1 Tube (6″ x 1″ diameter) made from narrow bottle.

1 Atomizer bulb.

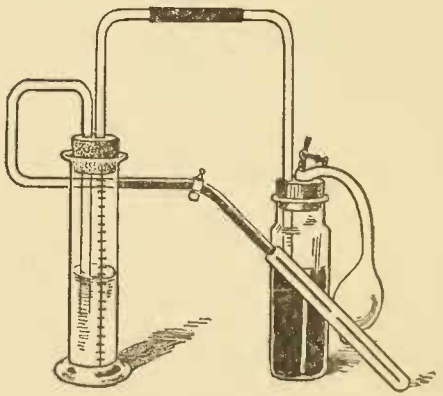
3 Glass taps, or pinch cocks.

3 Rubber corks to fit tube, cylinder and bottle.

1 Thin one-holed cork (to hold FeS in tube).

Rubber connections and glass tubing.

Chemicals:—Ferrous sulfid.
Hydrochloric acid.



This Novel Hydrogen Sulfid Gas Generator Can Be Constructed from Parts Found About the Workshop.

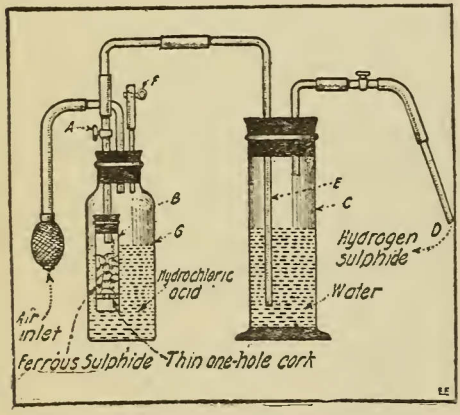
The essential working of the generator is as follows:

When tap A is turned (see figure) the acid rises in tube B, coming in contact with the ferrous sulfid, thus generating hydrogen

sulfid gas, which, passing through the wash bottle C is purified and escapes at D.

Use of the Bulb.—The pressure in tube B required to overcome the counter pressure exerted by the water in the wash bottle is often strong enough to force down the acid in the tube B, and thus from further contact with the ferrous sulfid. The result is "no gas." Upon squeezing the bulb, however, the pressure is overcome and the acid rises in tube B, thus forcing out the gas. I have proved this in practise. It is essential that a bulb having an air inlet is employed, otherwise it is useless.

Use of the Pinch Cock "F."—In order that the acid may rise in tube B it is necessary to open the pinch cock F to admit air.



Details of Hydrogen Sulfid Gas Generator.

This is also necessary, when shutting off the generator, in order to expel air, but it should be kept closed when the acid has reached "low level," to prevent rise in case of leakage or lessening of pressure, due to the hydrogen sulfid dissolving in the acid.

Any amateur chemist may set up this apparatus without much expense and I am confident that, if constructed upon this plan, it will give no trouble and the result is an odorless and convenient generator which makes a fine looking piece of apparatus for any laboratory.

CHEMICAL WRINKLES.

To Render Water Surface Phosphorescent.—Wet a lump of loaf sugar with phosphorized ether, and throw into a basin of water; the surface of the water will become luminous, and glow beautifully in the dark. By gently blowing upon it, phosphorescent undulations will be formed, which will illuminate the air above the fluid for a considerable space. In winter the water must be blood warm.

To melt a coin in a nut shell.—Mix three parts of dried niter, one of sulphur, and one of fine dry sawdust and press into a walnut shell, also inclose within the shell a piece of silver or copper, then fill the shell with more powder and set fire to it. The metal will soon be melted while the shell will be merely blackened.

The alchemists' dyes.—Dissolve indigo in diluted sulphuric acid, and add to it an equal quantity of solution of carbonate of potash. If a piece of white cloth be dipped in the mixture, it will be changed to blue; yellow cloth in the same mixture will be changed to green; red to purple; and blue litmus paper to red.

Two solids make a liquid.—Rub together in a mortar equal quantities of crystals of Glaubers salts and nitrat of ammonia, and the two will slowly become a liquid.

MAKING A SOLID FROM TWO LIQUIDS.

Make up a transparent solution of zinc sulphate. Fill a glass half full of zinc sulphate solution and another half glass full of strong ammonia. Pour them together and if the proportion be properly calculated the two liquids will form a solid so apparently dry that on inverting the glass containing it not a drop will fall out.

TO MAKE SOLIDS FROM LIQUIDS.

The spectacle of changing liquids into solids is at once both beautiful and mystifying.

Pour a concentrated solution of water glass (sodium silicate) into a glass and add enough hydrochloric acid to make the solution acid. The solution will turn into a solid resembling an opal and if the dish is inverted, will not fall out.

Dissolve a lump of alum in water and add enough ammonia water so that the solution smells strongly of it. Shake the mixture and it will turn into a thick transparent jelly.

HOW TO MAKE A VOLCANO.

Take a bowl or crock about 6 inches in diameter and fill it up with earth, so that it resembles a miniature mountain. Make a hole about ¾ of an inch in diameter and 6 inches deep for the crater.

Fill up this crater with a mixture of potassium chloride 3 parts, sulphur 1 part, charcoal 1 part, wax 2 parts and sugar 2 parts. Now light the mixture in the crater. The result will be a dense smoke, fire coming from the crater with lava pouring down its sides.

ACCIDENTS WITH ACIDS.

When strong mineral acids (nitric, sulphuric, and hydrochloric acids) are used for experimental purposes it is a good plan to keep some washing soda handy in case of accident. If acid is spilled on the floor or table, a little soda should be sprinkled over it at once, and afterwards removed with a wet rag. Another useful dodge is to keep a saucer on the table in which the glass stoppers of acid bottles can be placed when removed. Of course, the stoppers should be put back in the bottles immediately after use, not only to prevent fumes escaping into the air (in the case of nitric and hydrochloric acids) but also to preserve the liquids from dust and deterioration.

INTERESTING EXPERIMENTS FOR THE AMATEUR CHEMIST.

The following experiments can be performed with household chemicals:

If you possess a battery giving from 4 to 20 volts you can perform the following experiment, which is particularly interesting on account of the variation of results, with apparently the same conditions:

Immerse two pieces of brass in a strong solution of common salt or sal-ammoniac and water. Connect one piece to the positive wire and the other to the negative, taking care that the brass pieces do not touch each other.

After the current has passed for one or two minutes the solution will become colored, and if the process is continued a colored pigment will be precipitated. The color of the precipitant varies considerably and may be either red, purple, green, blue, orange and possibly others, depending on the strength of the current and the composition of the brass.

The Grand Rapids can be made as follows: Fill a tumbler or test tube with water, throw upon its surface a few fragments or thin shavings of camphor gum and they will instantly begin to move and acquire a motion both progressive and rotary, which will continue for a considerable period of time. If the water be touched by any greasy substance the floating particles will reverse their course and dart back and, as if by a stroke of magic, be instantly deprived of their motion and vivacity.

A Rival to Jack Frost is produced by dissolving camphor gum in warm spirits until the spirits will dissolve no more; pour some of the solution into a cold test tube or

tumbler and the camphor will instantly crystallize in beautiful forms like trees and landscapes.

This next experiment sounds as if it were "bigger," but it is not. Dissolve 150 parts of hyposulphite of soda in 15 parts of water and pour the solution slowly into a test tube or tumbler which has been heated in boiling water; fill the same about one-half full. Dissolve in another glass 100 parts of acetate of soda in 15 parts of boiling water. Pour this solution slowly on the top of the first in such a way that it forms an upper layer, without mixing the solutions. The two solutions are then covered over with a thin layer of boiling water and allowed to cool. Lower into the test tube a wire, at the extremity of which is fixed a small crystal of hyposulphite of soda. The crystal traverses the solution of acetate without causing trouble, but crystallization will immediately set in as soon as it touches the lower hyposulphite of soda solution. When the hyposulphite of soda solution becomes crystallized, lower in the upper solution a crystal of acetate of soda suspended by another wire and this will crystallize the same as the other solution.

RADIO-ACTIVITY FROM GAS MANTLES.

Here is an interesting experiment on Radio-activity. I obtained some Welsbach gas mantles, powdered them and placed the same in a cardboard box. I then put a key in the powder and covered it with a piece of cardboard, on top of which I laid a piece of sensitized photographic paper with the sensitized surface down. The above operations were all done in a dark room lighted only by a ruby lamp. The box was then covered and left in a dark room for one week. At the end of this period I found that upon developing the photographic paper that there was an indistinct impression of the key on the same. The radio-active rays which are a property of the rare metal, Thorium, a small quantity of which is contained in these mantels, had passed through the cardboard and affected the sensitized paper.

HINTS ON LABORATORY APPARATUS.

To most experimenters chemistry undoubtedly proves a most interesting study. However the chief fault lies in the fact that things mess up so easily. The following is intended to overcome this difficulty.

First of all the laboratory should be arranged that the one who uses the room may be able to find everything he wants.

A gross of empty wooden boxes, 12 inches x 8 inches x 4 inches, will be found convenient for keeping dry reagents in.

Labels should be used freely, and all unlabelled bottles washed out. Paper labels on bottles may be protected by a coating of paraffin wax, varnish or shellac. But most bottles should have some label in the substance of the glass. These are made in two forms. Enameled labels are melted on the glass. They last well, but white enamel is not always distinct when white crystals are in the bottle. Sand-blast labels are made by roughening the surface of the glass with a jet of sand driven by a blast of air. They are apt to be indistinct when wet, if not made with a really rough surface. They can be made more distinct by rubbing over with crayon or chalk. Sand blast labels cost only about half as much as enamel labels.

Retort stands should be firm and substantial. The sliding collars for the rings should be slotted at the sides, so as to move easily; and a good clamp should be chosen with well-made screw threads.

Deflagrating spoons can be cleaned by holding the cup in the Bunsen flame for a few seconds.

Bunsen burners occasionally get blocked by some molten substance falling into the inner tube. They may be cleaned by washing with water. After washing blow through the burner to remove any drop of water which may clog the exit. The revolving tube or ring should be frequently turned, so as to keep it in order; otherwise they get jammed and it is impossible to change quickly from a yellow to a blue flame.

Balances should turn with much less than a centigram. Balances with steel knife-edges, if protected from the air of the laboratory, will remain serviceable for years. Those with agate edges set in steel are more durable, but are more expensive. Weights less than a centigram are needless, and cause trouble to beginners. More exact weighing can always be done by watching the pointer, if the weights are accurate.

Management of mercury. Mercury is difficult to manage, on account of its weight and the ease with which it picks up impurities. Stone-ware mortars are better for holding mercury than glass beakers, which easily crack when set down. All operations with mercury should be conducted over a tray or on a table with a groove around the edge.

Dust on the surface of mercury may be removed by allowing the mercury to run through a dry filter paper in which a few pin holes have been made. Or the mercury may be washed in a current of water, and then passed through a separating funnel. The little moisture on the surface may be removed with a blotting paper. Many metals easily dissolve in mercury; and a very little tin or zinc will spoil its fluidity. They are best removed by shaking the mercury in a bottle with a little nitric acid; the tin or zinc will then dissolve, leaving the mercury pure.

A few words of caution concerning the care of reagent bottles are in place here. A good reagent bottle must have its stopper ground to fit it, and this stopper will not fit any other bottle you may have. Consequently the stoppers should never be interchanged. Again, the stoppers of all reagent bottles, excepting sulphuric acid, should be paraffined, otherwise they are apt to stick.

Do not lay down the cork of a reagent bottle while pouring out a solution, as the stoppers may become changed. Again, no solution but the one corresponding to the name on the bottle should ever be placed in the bottle.

Another important item is that each bottle shall have its own particular place on the shelf, and always be put in its place; thus the amateur chemist will know exactly where to find the proper reagent, just as a printer knows where to find the letters in his case, by prearrangement.

USEFUL LABORATORY INFORMATION.

Rain water may be used as distilled water, providing it is clean.

Baking soda is sodium bicarbonate.

Vinegar contains dilute acetic acid.

Common table salt is sodium chlorid.

Rust from a nail or other iron is ferric oxid.

Tea contains tannic acid.

Blackboard chalk is calcium carbonate.

Epsom salts is magnesium sulphate.

Sugar of lead is lead acetat.

Aqua fortis is nitric acid.

Aqua-regia is a mixture of nitric and hydrochloric acids.

Sal ammoniac is ammonium chlorid.

Sal soda is sodium carbonate.

"Hypo" is sodium thisulfate.

Denatured alcohol is principally a mixture of wood and grain alcohol.

A porcelain mortar or pestle makes an excellent whet-stone.

Aqua ammonia is ammonium hydroxid.

"Lye" or caustic soda is sodium hydroxid.

Quicklime is calcium oxid; slacked lime is calcium hydroxid.

German silver contains no silver.

Freshly prepared ferric hydroxid is an antidote for arsenic poisoning.

The glue on postage stamps is dextrin.

Quartz is silicon dioxid.

The ruby, sapphire and other gems are composed mainly of aluminum oxid.

Borax is sodium borat.

Salt-petre is potassium nitrat.

Copperas is ferrous (iron) sulphate.

Blue-stone is copper sulphate.

Hydrochloric acid and ammonium hydroxid are solutions of a gas in water.

Oxygen is made by heating potassium chlorat with manganese dioxid.

Carbon dioxid is prepared by treating marble chips with strong acid.

Hydrogen is prepared by treating zinc with strong acid.

Chlorin is easily prepared by heating a mixture of hydrochloric acid and manganese dioxid.

Sulfur dioxid is made by burning sulphur in air.

Nitrogen may be prepared by heating ammonium nitrit.

Pure silver may be prepared by treating silver nitrat with copper.

The silver is deposited as a gray powder, and may be collected by fusing into a solid.

THE PROPER USE OF SULPHURIC ACID.

This article is written for the benefit of amateur electrical and wireless experimenters as well as those interested in chemistry, not familiar with the dangers which may arise if sulphuric acid is not properly used.

Sulphuric acid is chiefly used in electrical experiments in the construction of electrical batteries. It is commonly and commercially known as "sulphuric acid," but there are other names under which it is termed and sold, i. e., "hydrogen sulphate," "hydric sulphate," "oil of vitriol," etc.

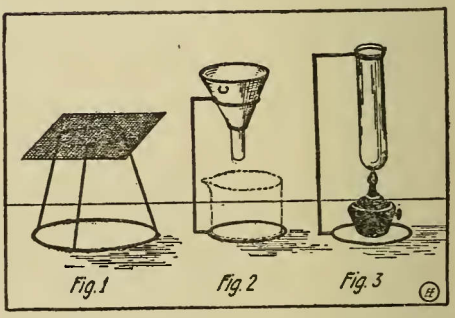
It is a thick, heavy, oily, sour and corrosive liquid, and in its pure state is without odor or color. It boils at 338 degrees and freezes at about zero.

The fact has been repeatedly illustrated in experiments already performed that sulphuric acid has a very strong tendency to absorb water and form compounds with it, thereby causing great heat to be formed in this action, and attention is called to the necessity for caution in mixing the liquid.

ALWAYS POUR sulphuric acid IN SMALL QUANTITIES INTO the water while stirring the same VIGOROUSLY. It is also well to work with such chemicals as sulphuric acid, nitric acid, hydrochloric acid, etc., where a draught of air can be created to prevent the poisonous fumes from being inhaled into the lungs.

USEFUL CHEMICAL HINTS FOR AMATEURS.

In many chemical experiments a ring-



Several Useful Wrinkles for the Young Chemist Are Here Suggested. The Stands Shown Can All Be Made of a Piece of Wire, Properly Bent.

stand is needed, but as these are somewhat expensive a substitute will be welcome. The stand is made of two rings of heavy iron or copper wire, one larger than the other, with three supporting legs. The ends of these are bent around the rings at equal distances. The stand should be covered

with a double thickness of screen-wire upon which the vessel to be heated is placed. The stand should be of the proper height in relation to the heater (lamp or Bunsen burner). This stand is illustrated in Fig. 1. A funnel stand is shown in Fig. 2 and a test-tube stand at Fig. 3.

An inexperienced visitor to your laboratory will be mystified and his admiration increased when you unconcernedly dip a piece of copper into a liquid in a bottle and bring it out coated with what seems to be silver. The liquid is prepared by dissolving a drop of mercury in a little nitric acid.

If some paper that has been soaked in starch solution and dried is dropped into a mixture of sulfuric acid and potassium permanganate, it will flash several times and throw a very light black residue for several inches. This experiment looks like a miniature volcano.

Invisible ink may be made by diluting one part sulfuric acid with twenty parts water. This ink is visible only when heated very hot.

SOME USEFUL WRINKLES FOR THE EXPERIMENTER.

Turpentine makes a very good lubricant for a drill when boring thin glass.

A liberal coating of paraffine on the outside of battery jars keeps the acid from climbing.

It is hopeless to try to restore dry cells to their former strength, but after they have lost most of their voltage they can be partially restored by drilling a number of holes around the base of the battery and soaking in a solution of salt water.

A very good way to intensify weak radio or telephone signals when using only a single pole watch case receiver is to procure a large magnet from some electrical supply store. Bind one of the poles on the back of the receiver where the screw that holds the bobbin protrudes (some little experimentation will have to be done to determine the right pole), and the signals will be found to have been increased to three and four times their previous strength.

Never try to tap your local telephone line. The company dislikes it; in fact, so violently that they may have you arrested on a serious charge. Many an innocent experimenter has gotten himself into a lot of trouble doing this.

Never try to make hydrogen gas without some knowledge of safety appliances to be used on the apparatus. It is about as quick a way to put your eyes out as there is.

If you are using storage batteries in your wireless set, and they fail to give proper voltage, or get too hot, don't try to fix them yourself, as they can be very easily ruined. A garage man can't fix in a day what you can "unfix" in 10 minutes.

Don't light matches around storage batteries to see if they are working properly. When operating they liberate a gas which is at times very explosive. Use a pocket flashlight.

If you are disturbed by alternating currents interfering with your wireless receiving set turn your aerial in another direction. It may help.

If you can get your wireless instruments silver plated, do so by all means, as silver is a much better conductor than nickel, and high frequency currents such as are used in wireless work travel almost entirely on the surface of switches.

If you are intending to buy any instrument and don't know the size, range, adaptability to your requirements, etc., don't be afraid to ask the manufacturer about the instrument. Even if he does have a catalogue, he will be glad to give you any additional information you desire.

When experimenting with 110-volt current always have a pair of 10 amp. fuses in circuit. It will stop a lot of pyrotechnics if something goes wrong.

Don't paint the stand that you intend to mount your instruments on. Paraffine is better; it doesn't allow so much current to leak through.

CHEMICAL LANDSCAPES.

These are drawn partly in India ink and partly in sympathetic inks, which are only visible when gently heated. The picture represents ordinarily a winter scene, but when heated the sky becomes blue, the leaves green and flowers and fruit are seen. The materials are as follows: Green, chlorid of nickel; blue, pure chlorid of acetate of cobalt; brown, bromid of copper. If the picture is too highly heated it will not again fade.

MAKING A CRYSTAL BASKET.

Water will, especially when boiling, dissolve large quantities of various substances, which, when the water has cooled, are left behind in the form of most beautiful crystals, the shapes of which may vary with the substance employed. One may take advantage of this fact to make very handsome ornaments. It is also known that boiling water will take up a much larger quantity of alum than cold water. If we dissolve as much alum as possible in the former, as the liquid cools, crystals of alum will be deposited on any object placed in the fluid. A piece of coke or cinder allowed to stand in a boiling solution of alum, will become coated with numerous glistening crystals as the liquid cools. It will have the appearance of a naturally formed mineralogical specimen.

Ornamental baskets, etc., may be formed in this way by covering the wire or willow baskets. The baskets covered with wire and then cotton are the most successful as the surface to be coated with crystals must be somewhat rough. Take twice as much water as will be sufficient to cover the basket, boil it in a saucepan and add as much alum as will dissolve in the water. A quart of water will require about 18 ounces of alum. Strain this through muslin or blotting paper into a large jar and hang the basket in the boiling liquid. Stand the jar on one side to cool and keep free from dust. In a few hours the basket will be completely covered with white crystals of alum. Should it be desired to color the crystals, add the requisite dye-stuff to the alum solution before straining it. A few drops of cheap dyes will serve the purpose well.

HOW TO MAKE A CHEMICAL GARDEN.

Place a quantity of sand in a wide mouthed bottle or fish aquarium to a depth of about three inches. Slightly imbed a few pieces of copper sulfate, aluminum sulfate, iron sulfate, chrome alum, lead acetate, calcium chlorid, magnesium and manganese sulfates, in the layer of sand (all these chemicals can be purchased at any drug store). Make a solution of water glass (sodium silicate) one part water glass and three parts water, pour this solution carefully over the sand and chemicals. In about a week a dense growth of the silicates of the various bases will be seen, in various colors and fantastic shapes. Now displace the solution of the water glass with clear water, by conveying a small stream of water through a small rubber tube into the vessel, which will gradually displace the solution of water glass. Care must be taken not to disarrange or break down the growth with the stream of water. Other sulfates such as chromium, nickel, cobalt, etc., may also be used. When successful this produces a very beautiful scene.

METALLIC TREES.

To Make a Silver Tree.

Dissolve two ten cent pieces in 2 fluid drams (about a dessertspoonful or two teaspoonfuls) of concentrated nitric acid, evaporating nearly to dryness to drive off excess of acid (evaporate by holding solution over a flame). Cool, and dissolve the resulting crystalline salts in sufficient distilled water to make a saturated solution. This solution will be slightly blue on account of the copper which is alloyed with coin silver. Place the solution in a glass vessel having a curved bottom. Add a drop of mercury the size of a large pea and set aside for a day. A large growth of mercury and silver amalgam will be produced which may be kept indefinitely.

To Make a Lead Tree.

Place in a tall jar (a quart preserving bottle will answer the purpose) a solution made by dissolving 4 ounces of lead acetate in one quart of water. Place the bottle where it will not be subject to vibration and suspend in it a strip or cylinder of zinc; battery zinc will answer the purpose very well. An abundant growth of crystalline spangles will collect on the zinc within ten days.

To Grow a Tin Tree.

Dilute commercial tin chlorid solution with forty times its bulk of water and proceed the same as when making the lead tree.

CHEMICAL GROWTHS RESEMBLE FOLIAGE.

The following item may prove of interest to your chemical readers and those who dabble in chemistry just for the novelty of such experiments as this:

A 10% solution of sodium silicate (water glass) is put into a glass or beaker, and crystals of any or all of the following salts are dropped in; copper sulfate, ferrous sulfate, nickel sulfate, cobalt nitrat.

Many other salts will give similar results but the various sulfates appear to be the best.

Shortly after the crystals are placed in the solution, they will begin to grow in fantastic shapes, each of the salts giving a different growth of different color. These growths look so much like undersea foliage that they have often been called "Submarine Gardens."

The rate of growth depends on the strength of the silicate solution as the crystals are due to a formation of the silicate of the salt used. A solution of the strength mentioned above allows the crystals to grow in a more even manner at a rate which can be watched. The growths, however, will not keep unless the solution is very weak, and then they grow too slowly.

SOME INTERESTING CHEMICAL EXPERIMENTS.

Procure at a drug store, or elsewhere, some phenolphthalein. Dissolve as much of this as possible in one fluid oz. of grain alcohol (C_2H_5OH). Add water to this until a permanent milkiness is observed in the solution. Now add more alcohol until the cloudiness disappears. The solution is now ready for use, provided that it does not cloud when a small amount of water is added to it.

This solution of phenolphthalein, when used in the *wine trick,* imparts an odor of alcohol to the wine-colored solution. Instead of using ammonia water (NH_4OH) in the third glass, use a solution of caustic soda (Na OH), since the caustic soda has no betraying odor as does the ammonia. For the same reason, use diluted sulphuric acid (H_2SO_4) instead of the acetic acid.

The following is an extremely interesting color experiment: Obtain some iodic acid solution (HIO_3) and either make or buy

some sulphurous acid solution (a solution of sulphur dioxide in water H_2SO_3). Take definite proportions of the two solutions and mix them together. Note carefully the time of mixing. In about twenty or thirty seconds the solution will turn black and in about three seconds more it will turn colorless again. By varying the proportions of the ingredients the time intervals of the color changes will also be varied. For the same proportions of the substances the time will be the same. In this manner one can predict at just what second the changes will appear. It might be well to add that a fair amount of light (natural or artificial) is necessary for the success of this experiment.

Another so-called *freezing trick* depends upon the conditions existing in supersaturated solutions. If such substances as sodium thiosulphate (hypo) are dissolved in water at about 100° F. until absolutely no more of the crystals will dissolve, and the solution is allowed to cool, it will be *supersaturated*. This solution will become a solid mass if the smallest crystal of the hypo is allowed to drop into it. With a little dexterity the operator can pass his hand over the vessel containing the solution and secretly drop into it a small crystal of the salt. A weird effect is produced when the solution immediately becomes solid. The explanation of this phenomenon is that the cold solution contains more of the salt that it could normally hold at that temperature, and when even the tiniest crystal of the salt is dropped into the solution, the whole becomes a solid mass. The solution must be freed while hot from the surplus hypo and allowed to cool slowly.

TESTED CHEMICAL LABORATORY STUNTS.

Fire-Proofing Cloth.—First get two glass tumblers. Add two teaspoonfuls of ammonium chloride to the water in the glass and stir until dissolved.

In the other glass put a piece of cotton cloth two or three inches square and then pour the dissolved ammonium chloride into the glass containing the cloth and see that it is well soaked with the solution. Hang the cloth up and let it dry. Then touch it with a lighted match. It will burn in the flame, but will go out as soon as the flame is removed.

To Make Gun Powder.—Mix one teaspoonful of potassium nitrate, one-half teaspoonful of sulphur and one-half teaspoonful of powdered charcoal on a sheet of paper. This must be thoroughly mixed to make a good powder.

Sympathetic Ink.—With a clean steel pen write on white paper with a cobalt chloride solution and let dry. When the paper is held near the fire the writing will gradually appear, and disappear again when it cools, because the chloride absorbs moisture from the air. Even though the paper is scorched the writing will still be visible.

Green Alcohol Light.—Dissolve one-half teaspoonful boric acid in two and one-half teaspoonfuls of alcohol and light it. The flame will be bright green.

To Remove Marks Due to Match Scratches.—Rub the scratched surface with lemon and then wash with a clean rag dipped in water.

TESTED CHEMICAL LABORATORY STUNTS.

Spoons That Will Melt in Hot Water.—Fuse together in a crucible 8 parts of bismuth, 5 of lead, and 3 of tin. These metals will combine and form an alloy, of which spoons can be easily made which possess the remarkable property of melting in hot water, coffee or tea.

A Self-Dancing Egg.—Take a thin glass tube about 3 inches long and fill it with mercury then seal both ends with good hard wax. Next have an egg boiled and then break a small piece of the shell from the smaller end and thrust the tube with the mercury in, lay it on a table and it will not

cease tumbling until the egg is cool. The same can be done by taking a small bladder putting a little mercury inside and blowing it up, then warm the bladder, it will skip about as long as the heat remains.

To Give a Piece of Charcoal a Coat of Silver.—Lay a crystal of silver nitrat upon a piece of burning charcoal; the metallic salt will catch fire and will emit sparks of various colors. The silver is reduced, and, in the end, produces upon the charcoal a very brilliant and beautiful appearance.

In Water But Not Wet.—Powder the surface of a large or small vessel of water with some lycopodium, which may be obtained at any drug store; you may then challenge any one to drop a coin into the water, and that you will get it without wetting your hand. The lycopodium adheres to the hand and prevents its contact with the water.

Artificial Petrifactions (turning into stone).—In a retort place a small quantity of pounded fluor-spar and sand, and pour upon it some sulfuric acid; fluosilicic acid gas will be disengaged, holding silex in solution. The subjects you wish to petrify must be moistened with water and placed in a vessel connected with the neck of the retort, the silex will be precipitated upon them like a frost and will have a beautiful appearance. It will wear for years. Note —Do not inhale this gas.

An Experiment With Sugar.—Take about 5 or 6 pieces of lump sugar and place them in a cup; next pour about 3 tea spoons full of boiling water upon them, and then add some sulfuric acid. It is truly a wonderful spectacle, and more instructive than reading, to see the sugar turn black, then boil, and now, rising out of the cup in a black color. It is now charcoal.

To Melt Steel.—Heat a piece of steel to redness in a fire, then hold it with a pair of pincers. In the other hand take a stick of brimstone or roll sulfur and touch the piece of steel with it. Immediately after their contact the steel will melt and drop like melted butter.

Explosion Without Heat.—Take a crystal or two of nitrat of copper and bruise them; then moisten them with water and roll them up in a piece of tin-foil, and in a minute the foil will begin to smoke and soon after will take fire and explode. Unless the crystals of copper are moistened, no heat will be produced.

To Melt Lead in Paper.—Wrap up a very smooth piece of lead in a piece of paper, then hold it over the flame of a taper; the lead will be melted without burning the paper providing there are no wrinkles in the paper and that it is in contact with the lead everywhere.

The Fiery Fountain.—If twenty grains of phosphorus, cut very small, and mixed with forty grains of powder of zinc, be put into four drachms of water, and two drachms of concentrated sulfuric acid be added thereto, bubbles of inflamed phosphorated hydrogen gas will quickly cover the whole surface of the fluid in succession, forming a real *fountain of fire.*

Ghastly Pleasure Party.—Dissolve common salt in an infusion of saffron and spirits of wine. Dip some tow in this solution and set fire to it, after extinguishing all other lights in the room. The ghastly effect produced on the faces of all present is very startling.

EXPERIMENTS OFF THE BEATEN TRACK.

The following experiments are not only interesting, but have the additional charm of novelty, being of a kind that one does not usually come across in the text-books.

For the first there will be required a bobbin about four inches in length with a central hole an inch or more in diameter and having a few hundred turns of double cotton covered wire wound on it.

This should be fastened end-up on a sheet of mirror glass and the ends of the wire connected with a source of rapidly alternating current.

Into the hollow core drop a few flakes of black magnetic oxide of iron, prepared as described below. At first no effect will be observed; but let a soft iron bar, or, what is better, a bundle of soft iron wire, be inserted for a moment and withdraw; the particles of oxide will at once become endowed with extraordinary activity. The flakes that were formerly at rest will be seen to be dancing vigorously under the influence of the alternating current, the movement being both side to side and up and down. The probable explanation is that the particles of oxide become permanently magnetized during the brief time that the iron core is within the bobbin. The polarity thus induced causes the particles—which, it will be remembered, are in the form of flakes—to present opposite ends to the middle of the bobbin alternately under the influence of the alternating current. The lateral movement is attributed to the mutual attraction and repulsion between neighboring particles.

To make the oxide in the form required for the experiment, cut a piece of tinned iron from a can and leave it in an open fire until the surface is covered with black oxide. If carefully removed and allowed to cool, a little gentle bending between the fingers will detach the oxide in the form of irregular flakes.

The next experiment is even less exacting in the matter of apparatus, only a little finely powdered graphite or bronze powder being required. The current, which may be drawn from the house supply, should be about 200 volts D.C. Two wires should be carried from the lighting circuit, provided with insulating handles for convenience, and having a high-resistance voltmeter in series.

Place a small heap of perfectly dry printers' bronze powder on a sheet of paper, and insert the ends of the wires in opposite sides of the heap. The voltmeter will not at first register the passage of a current; but upon gradually bringing the wires closer together the needle is ultimately deflected. After this they may again be separated without stopping the flow of current. Moreover, if the wires are brought fairly close together they may be slowly separated, not only from each other, but from the powder, without interrupting the flow of current. Upon inspection it will be found that the wires are connected either with each other, or with the powder, by an exceedingly fine thread of bronze. With care it is possible to obtain a separation of an inch or so. No doubt the chain is produced by a welding together of the minute particles composing it under the influence of heat, generated by the current. If graphite powder is used, several threads can be drawn simultaneously.

The third experiment to be described is of a very simple character, and only requires a carbon filament lamp and a perfectly dry, warm cloth. Immediately after switching off the current, that is while the lamp is still hot, it should be removed and rubbed briskly with the cloth. The outer surface becomes charged by friction and the inner surface by induction, sometimes sufficiently to attract the filament to the side and hold it there. At the same time a luminous glow is observed in a dark room.

SOME INTERESTING CHEMICAL EXPERIMENTS.

When a very little dry powdered potassium permanganat is moistened with sulfuric acid, brownish-green oily drops of permanganic anhydrid (Mn_2O_7) are formed. This compound is volatile, giving a violet vapor and is apt to decompose explosively into oxygen and manganese dioxid.

Its oxidizing power is such that combustibles like paper, ether and illuminating gas are set on fire by contact with it.

White phosphorus, when heated with sulfur unites with explosive violence. By using red phosphorus the action can be controlled. The product is phosphorous sulfid and the kind depends upon the proportions used.

If a small piece of sodium is placed on a piece of filter paper and placed on water, the water is decomposed and the heat liberated is sufficient to set fire to the sodium, which burns with a characteristic yellow flame.

Powdered magnesium and potassium chlorat in the proportions of 10:17 is used in making flashlights for use in photography.

Cordite, a variety of smokeless powder, is made by dissolving guncotton (65 parts) nitro-glycerin (30 parts) and vaseline (5 parts) in acetone. The resulting paste is rolled out and cut into small pieces. When the acetone evaporates the horny cordite remains.

Javelle water (solution of sodium hypochlorit) is an ingredient of ink eradicators. The solution is first applied to the ink and a dilute solution of hydrochloric acid is rubbed over it. The chlorin which is liberated is responsible for the bleaching effect.

CHEMICAL EXPERIMENTS.

No. 1: Put on a clean white plate or saucer, a mixture of pulverized sugar and potassium chlorat. Upon adding a few drops of sulfuric acid a vivid combustion will ensue. By adding with the sugar a few iron and steel filings, and performing the experiment in a dark room, or out of doors at night, fiery rosettes will flash through a rose colored flame, and produce a fine effect.

No. 2: Mix a teaspoonful of nitric acid with a teaspoonful of sulfuric acid; place a little turpentine in a teacup out of doors, and pour the mixture upon it at arm's length. The turpentine will burn with almost explosive violence.

No. 3: Make a saturated solution of sodium sulfate (Glauber's Salt), in warm water; pour the mixture in a bottle, and let it stand. The salt will remain for months without crystallizing; but if taken up, and shaken a few times, the whole mass will instantly form into crystals, so filling the bottle that not a drop of water will escape. Should there be any hesitation at the moment of shaking, drop a small crystal of the salt into the bottle, and the effect will be instantly seen, by the darting of new crystals in every direction.

No. 4: Heat a piece of tin until the coating begins to melt; then cool quickly in water and clean in aqua regia. The surface will be found covered with beautiful crystals of the metal.

No. 5: Pour dilute nitric acid upon bits of tin. Dense red fumes will pass off.

No. 6: Throw crystals of any nitrat on red hot coals; they will deflagrate with dense red smoke.

CHEMICAL EXPERIMENTS.

By experimenting a little you will find that an infusion of logwood chips and water will change color when other chemicals are added.

Take three glasses Nos. 1, 2 and 3 and prepare them as follows: Rinse No. 1 with strong vinegar; Dust No. 2 with powdered alum; Rinse No. 3 with a solution of copper sulfate. The next step is to pour the logwood into each. If the glasses have been prepared correctly the logwood in No. 1 will fade to a pale yellow. That in No. 2 will become almost black and that in No. 3 will change to a pale purple.

This is the principal set of changes but following is a list of changes using not only logwood but also other chemicals. Some of them can be used as stated above but in the case of ammonia for instance, the odor would give it away.

Color changes that are due to chemical action:

1.—Logwood, ammonia and copper sulfate gives a brown.

2.—Logwood, vinegar and ammonia gives purple.

3.—Logwood, alum and ammonia cause a red precipitate.

4.—Logwood, vinegar and copper sulfate gives a brown.

5.—Logwod, ammonia and common salt gives a light brown.

6.—Logwood, copper sulfate, common salt, and alum mixed give a pink.

7.—Phenolphthalein and ammonia gives a bright red (test for free ammonia).

8.—Copper sulfate and ammonia gives a bright blue (test for copper sulfate).

9.—Logwood and hydrogen peroxid gives a pale yellow.

10.—Logwood, copper sulfate and caustic soda gives a pale blue precipitate.

"POURING RED, WHITE AND BLUE FROM THE SAME PITCHER."

Fill 3 glasses 2/3 full of water. In the first dissolve 1 measure of Ammonium Sulfocyanat. In the second 1 measure of Strontium Nitrat and in the third ½ measure of Sodium Ferrocyanid.

In the pitcher dissolve 3 measures of Ferric Ammonium Sulfat in 1/3 glassful of water. Pour a little of this into each glass. The first will turn red, the second white and the third blue.

A FORTUNE-TELLING EXPERIMENT.

Procure a cylindrical carton about 2½ inches in diameter and at least a foot in length. Place in the bottom of this carton a small bottle, preferably an ink bottle, containing some pieces of iron sulfide (Fe_2S_3) covered with either hydrochloric or sulfuric acid. The cork of this bottle should have a hole about ⅛ inch in diameter drilled through it to allow the escape of the generated hydrogen sulfide gas. About an inch or so above this bottle (or generator) a round piece of perforated cardboard is held in place by resting on four common pins, the latter being placed at the ends of two diameters which are perpendicular to each other. These pins are thrust through the wall of the carton so that they protrude on the inside; thereby forming a basis of support for the perforated cardboard. The holes in the latter should be about ⅛ inch in diameter. Take a pad of ordinary unruled paper and write various fortunes on each sheet with a solution of lead acetate, commonly known as sugar of lead. The solution being colorless, the pad paper will appear to have no writing on it.

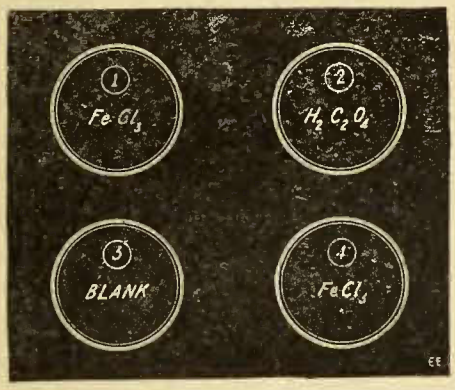
In telling the fortunes of your friends, have one of them sign his or her name on the top of a sheet of this pad. Tear this sheet off. Have another friend place his or her name on another sheet of the pad. After having three or four signed sheets, roll them up, place them in the carton, and quickly cover. Keep your friends interested by quoting some magic patter, and after placing the carton to the four winds and going through some magic motions, remove the cover and take out the roll of paper. Immediately cover the carton. Then distribute the sheets of paper to those whom the signatures designate. Behold! Your friends will receive the same signed sheets of paper covered with black writing which upon reading will tell their fortunes.

The chemistry involved in this experiment is the formation of the black precipitate of lead sulfide by the generated hydrogen sulfide (H_2S) coming in contact with the lead acetate $Pb(C_2H_3O_2)_2$ on the paper.

$$Pb(C_2H_3O_2)_2 + H_2S = PbS + 2HC_2H_3O_2$$

THE "REAL" WINE AND WATER TRICK.

Many of you have heard of or seen the so-called "wine and water trick" wherein



Arrangement of Four Glasses as Used in Producing "Wine and Water Trick" as Described.

a liquid, presumably water, is poured from a bottle into different glasses, which are apparently empty, and produces wine (don't drink it, for the love of Mike!) in some glasses and water in others. Various chemicals are used to produce this effect. One way is to have a crystal of potassium permanganate, K Mn O_4, in one glass, a solution of oxalic acid in another, and two glasses empty. Warm water when poured from a bottle into three of them will produce no result, but in the $KMnO_4$ glass a red color results. When all three glasses are mixed together the oxalic acid decolorized the $KMnO_4$. Still another method utilizes potassium-sulpho-cyanide and an iron salt, and a third method, phenolphthalein.

The writer has tried all of these with varying success. And then one day we talked to one of these wonderful prestidigitators (oh, yes; it's in the dictionary) and got the only and original formula for the real wine and water trick. You have only to try it to know it's the REAL one.

First secure four glasses. Put a very small drop of Fe Cl_3 (iron chlorid) in each of two of them, and fill another half full of $H_2C_2O_4$ (oxalic acid). The other one remains empty. The glasses with the chemicals should be farthest from the audience. Fill a flask with a solution of OHC_6H_4-CO_2H (salicylic acid). The table shows how to perform the separate operations of the trick in their proper order. That is, first pour some liquid from the flask into glass No. 3. Result—colorless. Then into No. 1. Result—red due to the formation of iron salicylate. Then into No. 2, colorless. Then into No. 4, red.

Two and four combined give colorless. One and three give red. All together give colorless. See table herewith:

$3 + OHC_6H_4CO_2H$ .....Colorless
$1 + OHC_6H_4CO_2H$ .....Red
$2 + OHC_6H_4CO_2H$ .....Colorless
$4 + OHC_6H_4CO_2H$ .....Red
$2 + 4$ .....Colorless
$1 + 3$ .....Red
$1 + 2 + 3 + 4$ .....Colorless

More glasses and chemicals may be used if desired, but must be prepared as above. To perform the trick pour from pitcher into glass No. 1 and we have *wine,* then into glass No. 2 we have *water,* and glass No. 3 we have *wine,* then glass No. 4 we have *water;* pour back glasses 1, 2 and 3 into pitcher and then fill the three glasses with *wine* from the pitcher, now pour all four glasses back and then fill them with *water* from the pitcher.

A little practise before you attempt this with your friends will enable you to handle glasses and pitcher skilfully.

Try to cover the solution in glass No. 4 with your hand when pouring into it for the first time.

CHEMICAL COLOR CHANGES.

The following chemicals should be dissolved separately in individual bottles, labeled properly and kept tightly corked:

No. 1.—Permanganate of potash, ½ dram; water, 4 ounces.

No. 2.—Caustic soda or potash, ½ dram; water, 4 ounces.

No. 3.—Hypsosulphite of soda (hypo), 2 drams; water, 4 ounces.

No. 4—Bichloride of mercury (poison), ½ dram; water, 4 ounces.
(Be sure and label bottle *poison.*)

No. 5.—Sulphat of iron, ½ ounce; water, 4 ounces.

No. 6.—Red prussiate potash, ½ dram; water, 2 ounces.

No. 7.—Oil of tartar, this is made as follows: Carbonate of soda or common washing soda, ½ ounce; water, 4 ounces.

No. 8.—Acetic acid (clear acid).

The above chemicals are all used in photography and may be purchased of any photo dealer.

In a tumbler containing a small quantity of water place enough No. 1 solution to give a nice wine color, then add about a half teaspoonful of No. 2 solution, this will slightly redden the No. 1 solution; now place a few drops of No. 3 solution, this will change to green; add a small quantity of No. 8, you will observe this to turn brown and then clear itself. Rinse tumbler out thoroughly.

Put about ten drops of No. 4 in half tumbler water, add a small quantity of No. 7, this changes to a deep orange color; now add a small quantity of No. 8, immediately clears itself. Remember that No. 4 is *poison* and should be handled with extreme care. Rinse glass thoroughly.

A small quantity of No. 5 in a half tumbler of water will be a clear solution and a small quantity of No. 6 in half tumbler of water will be clear; add both together and you will have a deep navy blue.

By further experimenting with above chemicals you will be able to perform many other changes.

CHEMICAL TRICKS.

The Popular Wine and Water Trick.

Obtain a small quantity of phenolphthalein from your chemist or druggist in powder form. Dissolve it in a small bottle and keep well corked. When ready for the trick (before the performance) place some of this solution in a small crystal or porcelain pitcher and partly fill with clear water, then prepare four wine glasses or small tumblers as follows: No. 1 glass with about a teaspoonful of ammonia. No. 2 glass clear. No. 3 glass with a teaspoonful of ammonia, and No. 4 glass with two teaspoonfuls of acetic acid.

Mysterious Smoke Trick.

Place a small quantity of ammonia in a tumbler and upon a small piece of clear glass place a few drops of muriatic acid. Tell one of your friends that you can find out whether he is an excessive smoker or not, and have him place his thumb on the under side of the sheet glass and carefully turn it over on top of the tumbler with his thumb still in position; the result will be an excessive amount of smoke issuing apparently from his thumb.

Mysterious Fire.

A small quantity of chlorate of potash mixed with the same amount of sugar placed on a piece of tin or stone and then touched with a stick dipped in sulphuric acid will instantly burst into a bright white flame.

If a small quantity of strontium nitrate is mixed with this the flame will be red instead of white, or if the same amount of barium nitrate is mixed instead of strontium the flame will be green.

POLE INDICATING SOLUTION FOR BATTERIES.

Formula.—Water, 1 teaspoonful; Phenolphthalein, 3 drops; Potassium Nitrate, 1 teaspoonful.

Directions for Use.—Dip wires into solution, and the one which is negative will color the solution about it red.

A NOVEL CHEMICAL INDICATOR.

In chemistry an indicator is something which tells whether a substance is acid or basic.

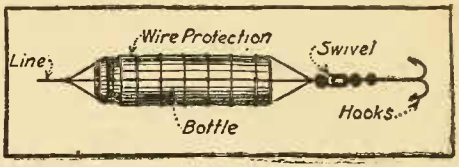
The following is a rather peculiar one:

Place some sulfate of quinin in a beaker and add some water. The sulfate of quinin will not dissolve. Now add dilute sulfuric acid drop by drop until the sulfate of quinin is all dissolved.

To test for a basic reaction add some of the above solution to the solution to be tested. If the solution is basic the sulfate of quinin will reappear as a flaky precipitate. To test for an acid make some of the test solution slightly basic and add solution to be tested. If the solution *clears* the substance is acid.

LUMINOUS FISH BAIT.

All fishermen know that a light will attract fish. The present device comprises a small bottle or vial wound with wire spaced one-eighth of an inch apart. Two hooks are swiveled to the end of the bottle with fish line, tying it to the main line above the bottle. A luminous mixture is then made. Heat some olive oil on the stove for about fifteen minutes, just sizzling and not boiling; then mix in phosphorus the size of a small pea. Put in the bottle and cork. This is a fine bait for bass and can be used



Attracting Fish by Means of a Luminous Bait and Hook.

to an advantage at night. It can be used in winter fishing when the lines are placed through holes in the ice.

CANNED HEAT.

Canned heat, a new discovery, is nothing else but solidified alcohol. The alcohol is suspended in a soap mixture so that it may be used for heating purposes and still not be open to the dangers from alcohol when burned alone.

Solidified alcohol may be made according to the following formula: Stearic acid, 8½ grammes; caustic soda, 1-35/100 grammes; alcohol (grain or denatured), sufficient quantity to make 100 grammes.

Dissolve the stearic acid in about 50 grammes of alcohol by the aid of heat. Dissolve the caustic soda in about 40 grammes of alcohol. Mix and warm until the two solutions combine. Pour into suitable moulds. The moulds ordinarily used are friction-top tin cans capable of holding three or four fluid ounces. To ignite, the cover is removed and a lighted match held over the solid mixture. To extinguish, the cover is slipped on the can. Care should be taken not to tip over the lighted can, as when the mixture is burning it becomes a semi-liquid and, therefore, a source of danger if spilled. When the fire is extinguished and the mass allowed to cool the contents of the can again solidifies. The soap itself does not burn but is left in the can after the spirit has been consumed.

TO SOLIDIFY ALCOHOL.

Heat 500 parts of denatured alcohol over a water bath to about 140 deg. F. and add 1 part of gumlac and 15 parts of dry Venetian soap (powdered).

TREE OF CRYSTALS.

Put a small quantity of bruised gum benzoin on a piece of thin metal or a saucer, invert it over a tumbler glass, in which place a sprig of wood, or any small-leaved plant, and apply the flame of a candle underneath, so as to melt the gum; dense fumes will soon begin to arise, and deposit themselves in most beautiful crystals of silky texture, on the sprig of wood, in delicate soft flakes, resembling foliage.

HOW TO MAKE ICE.

1. Ice can always be purchased cheaper than it can be produced in a small way. However, it is sometimes desirable to have ice or to secure extreme cold when it cannot be purchased, on Sunday or in the night. By use of the recipe below ice may be made at home in about 20 minutes.

Take phospate of soda.....9 parts
Nitrate of ammonia.....6 parts
Diluted nitric acid.....4 parts

Place the water to be frozen in a small dish (about 3 inches diameter) and put the dish in a large one, to hold the freezing mixture. It will require from 2 to 4 times as much of the chemical as of the ice desired. Hence, if 18 pounds of ice is wanted it will require about 18 parts of soda, 12 of ammonia and 8 of nitric acid. The outer vessel should be insulated by wrapping it in a wet blanket or paper. The water and utensils should be made as cold as possible by first immersing them in the coldest water available.

This is really a very cheap method of making ice, as the chemical may be used time and again by merely evaporating the water.

2. Gunpowder may be made by carefully mixing together 70 to 80 per cent of nitrate of potash, 10 or 12 per cent of sulphur, and 10 to 12 per cent of soft wood charcoal.

3. An interesting little experiment may be performed by throwing a piece of potassium as large as a pea upon some cold water in the bottom of a large bottle. Hydrogen is given off on account of the decomposition of the water caused by the potassium. Enough heat will be given off to ignite the hydrogen, which will burn with a purplish red color. Immediately after throwing the potassium in the water a pasteboard card or glass plate should be placed over the mouth of the bottle.

4. Rochelle salts may be obtained by the following experiment: Dissolve 10 grams of cream of tartar in about 175 cubic centimeters of hot water. Add to this a strong solution of sodium carbonate as long as the addition produces effervescence. Evaporate the solution to the bulk of 20 cubic centimeters and then allow it to cool. Crystals of Rochelle salts will be obtained.

For the benefit of those who do not understand the metric system, in which the measurements in the last experiment are given, the equivalents in the English system are: 10 grams equal 154.32 grains, 175 C.C. equal 5.9 fluid ounces, and 20 c.c. equals 7 fluid ounces.

FREEZING MIXTURES.

When ice or snow are not to be had and for those of us who do not have an up-to-date laboratory that is provided with agencies of cooling power, I am sure the following mixtures will prove most convenient.

1. Nitrat of ammonia, carbonat of soda and water, equal parts by weight; the thermometer sinks 57°.

2. Phosphate of soda, 9 parts, nitrat of ammonia, 6 parts; dilute nitric acid (acid 1 part, water 2 parts), 4 parts. Reduces the temperature from 50° to 21°.

3. Sal-ammoniac, 5 parts; nitrat of potash, 5 parts; sulphate of soda, 8 parts; water, 16 parts. Reduces the temperature 46° or from 70° to 24°. This latter is very cheap and easily procured.

If you have ice and wish to reduce the temperature still further, use the following:

1. Finely pounded ice, 2 parts; salt, 1 part. This is a very common recipe.

2. Finely pounded ice, 2 parts; crystallized chlorid of calcium, 3 parts.

3. Finely pounded ice, 7 parts; dilute nitric acid, 4 parts. This reduces the temperature from 32° to 30°. The temperatures given are Fahrenheit. The materials should be kept as cool as possible.

"CHEMICAL SNOW."

Two parts Strontium Nitrat are first dissolved in 20 parts of water. Dissolve 2 parts Sodium Carbonat in 10 parts of water (heat may have to be used to dissolve it). Pour the second solution into the first. The result resembles a miniature snow storm.

Sodium Carbonat and Strontium Nitrat react, forming Sodium Nitrat and Strontium Carbonat. The latter is not soluble in water.

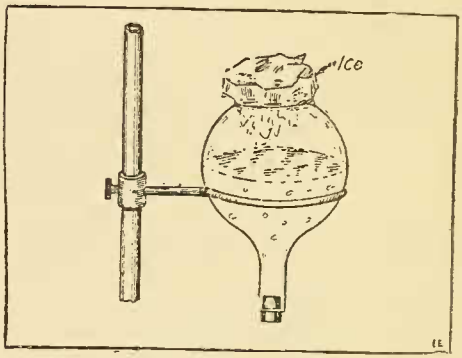
BOILING WATER WITH ICE.

This is an old, though very curious and interesting experiment, calculated to mystify the uninitiated.

Obtain a Florence flask or glass distilling retort and fill it half full of water. Boil the water, and immediately on removing the flame, cork the flask tightly, and turn it upside down. As soon as the steam condenses it will form a partial vacuum over the water. It is well known that water boils in a vacuum at a much lower temperature than is required in the open air, and consequently, if the vacuum could be kept up, the water would boil long after it was removed from the source of heat. But as soon as steam is formed, it exerts a pressure on the water and stops the boiling.

If now we place a piece of ice on the top of the flask, the vapor or steam will be condensed, a vacuum will be formed and the water will commence to boil violently and will continue to do so until the temperature of the water in the flask falls below that at which water boils in a vacuum.

If the ice be removed before this occurs, the vapor will again form, press on the water and stop the boiling; but the boiling may be renewed by replacing the ice.



If You Have Never Boiled Water With Ice, Here Is Your Chance! Next They Will Make Ice-Cream on the Gas-Range.

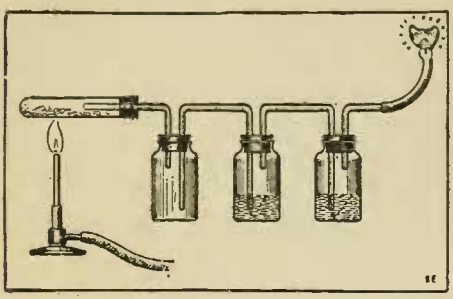
In performing this experiment, it is well to wrap the ice in flannel to avoid the dripping of the melted ice.

HOW TO MAKE, USE AND TEST COAL GAS.

A test tube is half filled with ground soft coal, packed loosely. The tube is heated and the gas allowed to pass through a bottle filled with air. Anything left in this bottle will be coal tar. The gas is then passed through lime water. If any carbon dioxid is present, the lime water will become *milky*. The gas is then passed through the last jar containing red litmus solution. This will turn blue in the presence of ammonia.

From the last bottle, the gas may be allowed to flow through a rubber tube in the end of which is a burner. The gas will

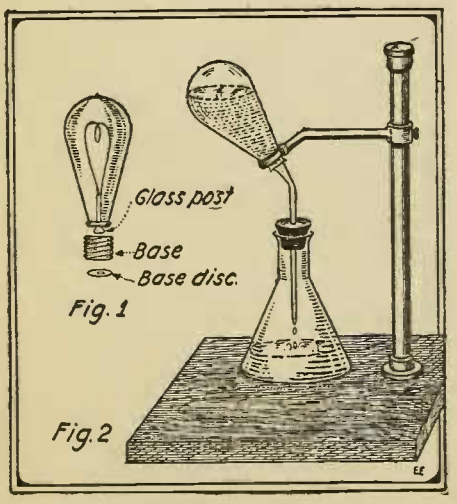
burn with a yellow flame. Using a 6" x ¾" test tube, this flame will give about 1 candle-power.



We Should Care Now If "It Goes Up!" We Will Make Our Own Gas and Laugh at the Consolidated!

DROPPER FROM OLD LAMP BULBS.

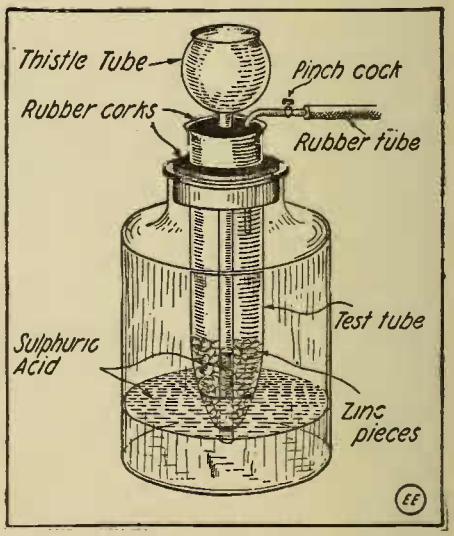
I have found a very good use to which old worn out electric bulbs can be put. First, the solder is melted from end of the base and the small disc is removed. Now, by using a little pressure, the entire base may be removed. Then, with a piece of heavy wire or a nail, the glass post on which the tungsten filament is attached, can be broken. The glass pieces and tungsten wire must then be removed. Care should be taken to keep the openings at the bottom as small as possible. If the bulb is now filled with water and quickly inverted, the water will not flow out but by slightly tilting it, the water will come out drop by drop. This makes a very good dropper for use in chemical experiments. If a rubber tube is attached as in Fig. 2 the dropper may be used on any receptacle.



The Burned Out Bulb in the Laboratory. Cheap and Efficient Dropper!

HOME-MADE GAS GENERATOR.

A neat and efficient hydrogen gas generator from which a supply of gas is available at any moment, can be very easily made of a wide mouth bottle, a test tube, two (preferably rubber) corks, a glass thistle tube and a wire pinch cock.



A Handy Gas Generator Made from Odd Parts Found About the Work-shop.

The bottom of a test tube is heated and drawn to a point, the point is then nicked off with a file leaving a hole large enough to loosely admit the lower end of a long thistle tube.

The thistle tube and a delivery tube are placed in a two-hole stopper and inserted in the test tube. The end of the thistle

tube should protrude from the test tube about one quarter of an inch.

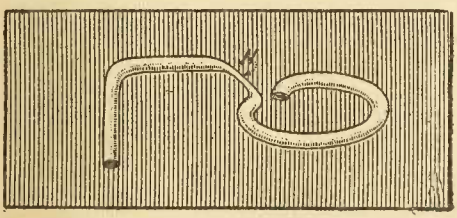
The test tube is then mounted in a large single hole stopper and placed into the neck of a wide mouth bottle. After slipping a piece of rubber tubing over the delivery tube, the apparatus is ready for use.

Place lumps of zinc to be acted upon by the acid into the test tube as shown. Now pour the diluted sulphuric acid (4 parts water, 1 part acid) into the thistle tube until it is full. The acid will soon reach the zinc and react with it, giving a steady supply of gas.

By closing the rubber tubing with a pinch cock the pressure of the gas in the interior will force the acid up the thistle tube, causing the chemical action to stop.

A CHEMICAL SIPHON.

This will be especially useful to electrochemists for siphoning off liquids from gravity batteries, etc. It is easily made by heating a glass tube till soft and drawing it out until of quite small diameter at the bend; it is bent as shown in sketch (aided by using a fish tail burner.)

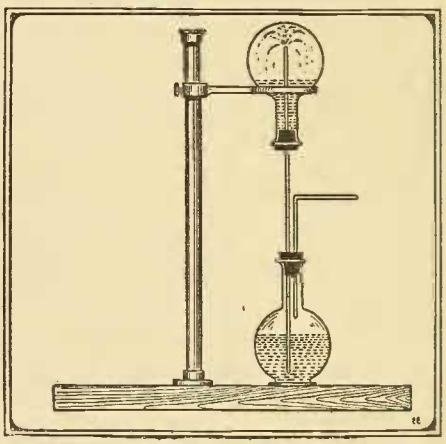


Simply Bend a Piece of Glass and Presto! That Much Desired Siphon Is Ready.

Its principle of operation is the "ram" action. Immersing it, keeping one finger closed over one end, and lower it horizontally into the shallow liquid. Remove finger and liquid will rush into tube, its velocity being sufficient to carry it up the narrow portion marked N, and over the bend.

SOLUBILITY OF GAS PRODUCES FASCINATING EFFECTS.

A very interesting chemical experiment can be performed with the apparatus shown in the illustration. A perfectly dry Florence flask is used for the upper vessel. It is filled with hydrogen chlorid gas, which



The Modern Heron Fountain. A Mysterious Trick of Fascinating Effects.

is prepared by heating a mixture of moistened common salt (sodium chlorid) and sulfuric acid. The gas is collected by downward displacement as it is heavier than air.

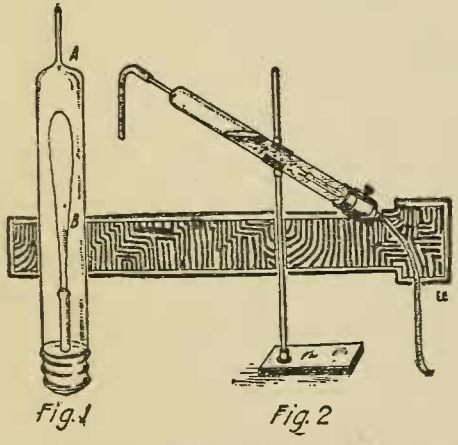
This flask is connected by means of a glass tube to a similar vessel, which is nearly filled with a blue litmus solution. This solution is made by dissolving a very small quantity of the blue litmus dye in water. The end of the tube, opening into the upper flask is drawn out, so as to make a rather fine jet. All the stoppers are fitted tightly

By blowing into the open tube of the lower vessel, a few drops of the liquid are forced into the upper flask. The hydrogen chlorid at once dissolves, thus diminishing the pressure inside the vessel. The blue solution then forms a fountain at the jet and continues to do so, until almost all the chlorid is used up. This gas has also the

property of changing blue litmus to red, hence as soon as the solution comes in contact with it, the color is changed immediately, thus presenting a very mysterious appearance to a novice.

EXPLOSIVE GAS APPARATUS.

Having occasion to make hydrogen gas to explode in a gas cannon, I thought of the following idea: I secured an old show-case bulb and broke the tip off. After removing the filament (B), I fused a piece of glass tubing on the bulb, as shown at (A). Then I filled the bulb half full of a sulfuric acid solution, screwed it in a socket, and clamped the whole on the stand, as in Fig. 2. By running a piece of rubber tubing from the tube to the cannon, I was able to get a good explosion. Care must

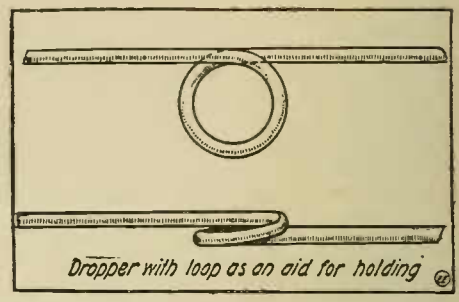


Explosive Gas Experimental Apparatus Constructed of Show-case Lamp with Tube Fused on Tip End.

be taken not to disturb the platinum terminals.

AN IMPROVED PIPETTE.

In chemical laboratories the most commonly used dropper consists of a straight glass tube. However, if the tube or one's hands are wet, the dropper is hard to hold. I overcame this difficulty by bending the tube so as to form a complete loop in it, of about three-fourths of an inch. One can



Place Your Finger in the Loop of This Improved Pipette and It Simply Can't Slip from Your Grasp.

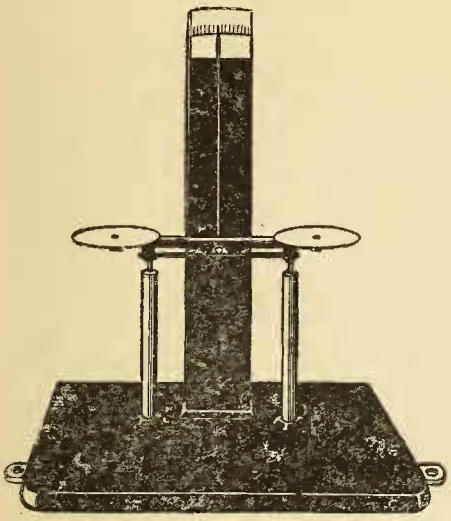
slip a finger through this loop and all danger of its slipping is eliminated. The sketch represents the improved dropper more clearly.

HOW TO MAKE A CHEMICAL BALANCE.

The accompanying photo illustrates a chemical balance easily constructed. While not being extremely accurate it nevertheless will measure quantities to the degree of accuracy generally demanded in an amateur's shop or laboratory. It is not difficult to construct and ordinary care being used, it can be made to weigh within a gram.

The illustration is self-explanatory, but a few words may not be amiss. To make it, first obtain a telephone ringer set as that shown in figure. It is not necessary to purchase a brand new one, but go to some electric or telephone repair shop where you may secure a ringer for less than fifty cents or even for nothing, possibly. Proceed to rearrange the different pieces so as to appear, after adding other parts, like that shown below. On the armature, solder or bolt a strip of metal, preferably aluminum, ½" x 7" and on the ends of this "beam" attach two circular 4" pans. Below one of the pans place a right angle strip and ad-

justing screw, in order to be able to make pans balance. Back of the instrument, after fixing on base, place a strip for an indicator.



Every Experimenter Needs a Small Balance for Weighing Chemicals On. Here's One Made from a Telephone Ringer Frame Fitted With a Set of Pans and a Scale.

Finished with shellac, this instrument will make a neat looking and useful little piece of apparatus for chemical or photographic work.

SIMPLE TESTS FOR LEAVENING CAPACITY AND PURITY OF BAKING POWDERS.

To ascertain the leavening capacity, place as many glass tumblers in a row as you have baking powders to test. Measure half a teaspoonful of each baking powder into a tumbler by itself, and fill two-thirds full of clear, cold water. Set the tumblers between yourself and the light, observing which throws off the larger amount of tiny gas bubbles. The one that liberates these in the greatest abundance, possesses the highest leavening power, as these tiny globules developing in the dough, cause it to rise and become light.

To test for purity place as many teacups in a row as you have baking powders to test. Deal a teaspoonful of each into its separate cup. Pour a very little boiling water from the teakettle into each and in about two minutes fill with boiling water. After they have stood half an hour to cool, pour each into a separate glass tumbler and set aside to rest. The baking powders that are pure and free from stuffing will be completely dissolved and the water will be as clear as crystal. The cloudiness and precipitate at the bottom of the impure ones will tell the amount of adulteration and of impurity. The tumbler with its solution as clear as crystal contains pure cream of tartar and no adulterants. The tumblers containing turbid solutions and yielding small precipitates contain little cream of tartar but phosphates of calcium and stuffing. The tumblers containing very turbid solutions and yielding heavy precipitates contain no cream of tartar, whatsoever, but plenty of alum and stuffing.

Baking powders containing pure cream of tartar are recognized to be the best by experts while those containing phosphates and alum are regarded to be unwholesome and detrimental to our stomachs.

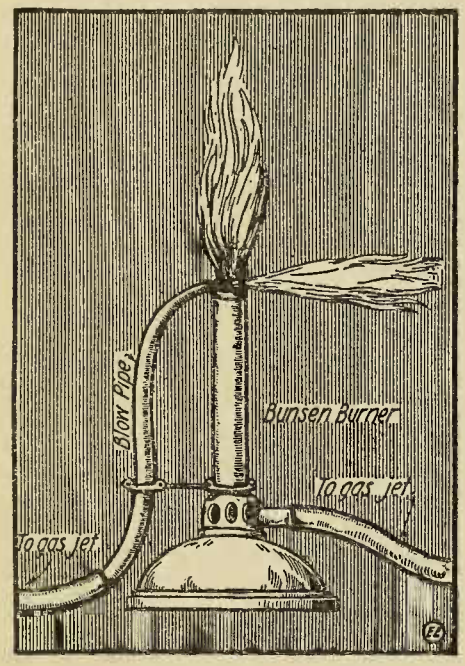
EXPERIMENT HOW TO MAKE GAS.

Take some hard coal and grind it up fine. Put it in the bowl of a clay pipe and put some plaster of Paris over the top to seal it. Then put the bowl of the pipe over or in the flame of the gas stove. In a few moments the gas will be coming out of the stem of the pipe and the same can be lighted.

A DOUBLE FLAME LABORATORY BLOW TORCH.

While working in a laboratory last winter I frequently needed a blow torch for welding purposes, but as there was none in the laboratory equipment I struck upon a novel means of making the desired heat. I attached a mouth blow pipe to a gas jet

by means of a rubber tube and, turning on the gas, held the blow pipe in the flame of a Bunsen burner. The gas coming through the blow pipe had the desired effect upon the Bunsen flame, producing as great or greater heat than the average blow torch.



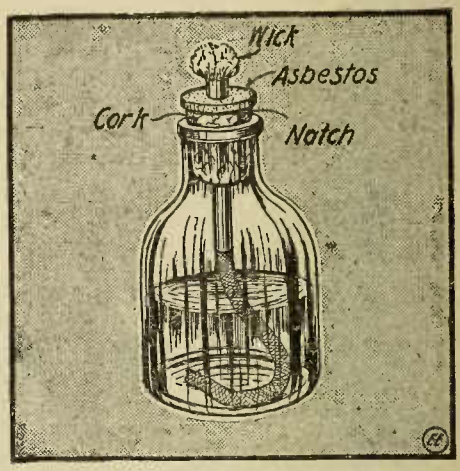
A Double Flame Laboratory Blow Torch.

A HANDY SPIRIT LAMP.

All that is needed to make this useful little spirit lamp are: An old ink or mucilage bottle, a wooden cork, a small tube, a piece of asbestos and an old lamp wick.

The cork should be made of hard wood and as seen in the diagram should have a hole bored through its center. Thru this a piece of metal tubing about 1½ inches long is inserted. There should be a notch cut in the side of the cork to admit air.

A piece of asbestos should be procured (a piece of an old asbestos shingle will do) about one inch in diameter with a hole bored thru the center to admit the tube.

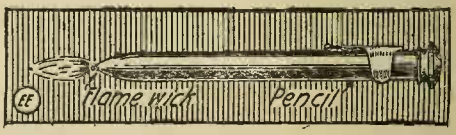


Useful Alcohol Torch.

The wick, which may be flat, should be run up through the tube to the desired height. Wood alcohol should be used as fuel as it gives intense heat and little smoke.

HANDY POCKET LAMP.

First obtain a worn out metal magazine pencil and remove the center. Next secure about 6″ of yarn and soak it in melted paraffine, take it out and let it become thoroly dry. Put it in the pencil case, allowing about ⅜″ to protrude from the end. When lighted this will burn steadily

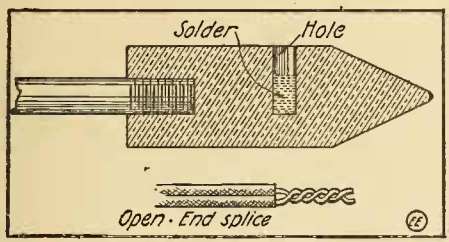


Pocket Lamp Made From Magazine Pencil and Some Cotton Wick.

for at least five minutes. When it has burned out, cut off the end and pull out about ⅜″ more.

RELATING TO THE SOLDERING IRON.

By drilling a hole in the side of a soldering iron and filling it with solder, splices of the open-end style may be soldered with

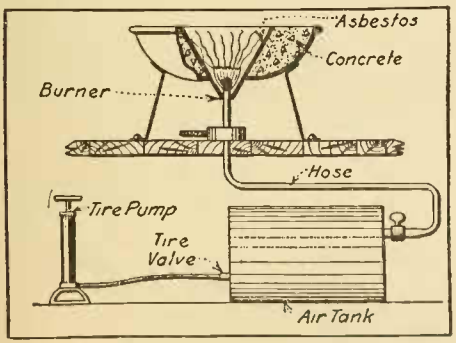


A Time-Saving Kink for Rapidly Soldering Twisted Wire Joints. A Solder Well Is Formed by Drilling a Hole in the Copper.

much better results than by using the tip of the iron. The iron is heated until the solder in the hole melts, then the splice, already covered with paste, is pushed into it. This makes a very well soldered joint. The hole should be about ¼"x⅝".

A SMALL FORGE FOR THE AMATEUR.

The construction of a small forge for the amateur is very simple. An old granite



Here Is a Way to Make a Handy Forge for Amateur Shop-work.

basin from the sink is filled with cement and a hole left for the fire box. While the concrete is still damp a sheet of asbestos is laid around the inside. This is to keep the heat in. A small tin funnel is put on the inside and the spout arranged to stick out underneath. Some rubber tubing is connected to this and thence to an old gasoline tank under the table through a stop cock to regulate the flow of air. The other end of the tank is fitted with a tire valve and an ordinary tire pump connected up as shown. Charcoal or coke may be used in this furnace.

HOW TO CHANGE THE TONE OF ANY GONG.

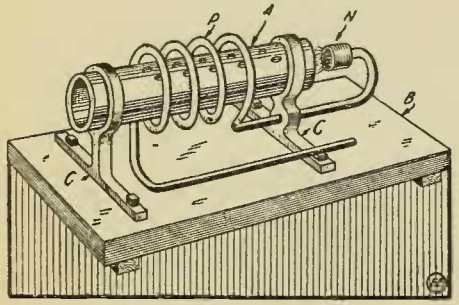
Take the ordinary gong and cut a deep groove or a slot in it with a hack saw and it immediately changes the tone to a cowbell.

A GASOLINE TORCH FOR THE EXPERIMENTER.

A very handy gasoline torch for the experimenter's laboratory can be successfully and easily built. This torch will develop a considerable amount of heat, which is frequently needed for certain experiments. The burner is made from a piece of brass tube, A, as illustrated in illustration. This should be ½ inch in diameter and 2½ inches long, plugged up at both ends, one end being drilled and reamed out to 5-16 inch. Three rows of holes 1-16 inch in diameter are next drilled in the tube as depicted. One row is drilled to come directly on top and the other two at about 45° from the vertical. It is then fitted to a sheet steel base, B, by means of the clips, C, C. A piece of ⅛-inch copper pipe, P, is next coiled around the brass tube, A, to form the vaporizing coil. This coil should have a diameter of about 1 inch. One end of the copper tube is bent around so it will point directly into the reamed out hole in the end of the brass tube, A. A nipple, N, is made by drilling a ⅛-inch hole half way through a piece of brass, topped to fit the ⅛-inch hole. A 1-64-inch hole is then

drilled through the remaining part of the nipple. The other end of the copper tube is connected to the supply tank.

The distance between the nipple, N, and the end of the tube, A, should be only 5-16 inch. The supply tank can be made from a brass tube 3 inches in diameter and 6 inches long, with the ends sealed by soldering on two end pieces of the same material. A small cock is provided, which is directly connected to the torch. A small



A Home-Made Gasoline Torch.

hole is made on the top of the tank to allow air entering the interior, in order to force the gasoline to the burner. Care should be taken in handling the gasoline, as it is very inflammable. It will be found that the torch will produce a hotter flame when the copper coil is quite hot; this is due to the fact that the gasoline is more readily vaporized and consequently a better mixture is produced.

In order to start this device vaporizing it is necessary at first to warm the coil by means of a match, or with a little gasoline ignited under the worm.

FILLING THE FOUNTAIN PEN WITHOUT DROPPER.

Oftentimes a person finds an occasion to fill a fountain pen, but he has no dropper handy. So here is a little trick to try on your fountain pen.

Take a pin or match, and draw a channel out to the edge of the mouth of the ink bottle, with the ink. The ink will follow this channel, and run into the fountain pen, without spilling a drop.

USE FOR AN ATOMIZER.

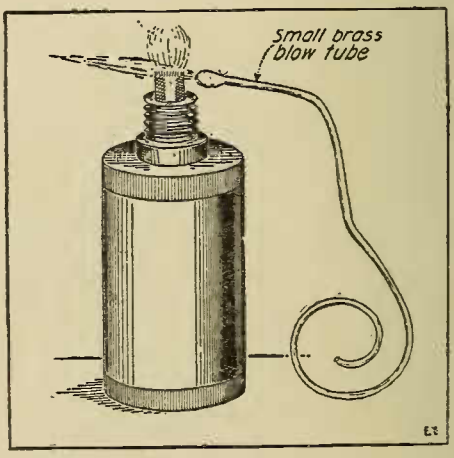
An atomizer is a handy appliance to furnish a draft of air when drying precipitates or evaporating solvents like ether or chloroform. The drying of precipitates and crystals can best be carried out when same is placed on a blotter to help absorb the liquid.

MACHINE OIL.

A good formula for light machine oil is submitted herewith. I have never found this oil to gum. Mix 2 oz. sweet or olive oil with 1½ oz. kerosene or coal oil. Then add 12 drops oil of citronella.

SPIRIT LAMP FROM FAN GREASE-CUP.

A novel but efficient spirit lamp can be made from a fan grease-cup when cleaned and filled with alcohol and a wick inserted.



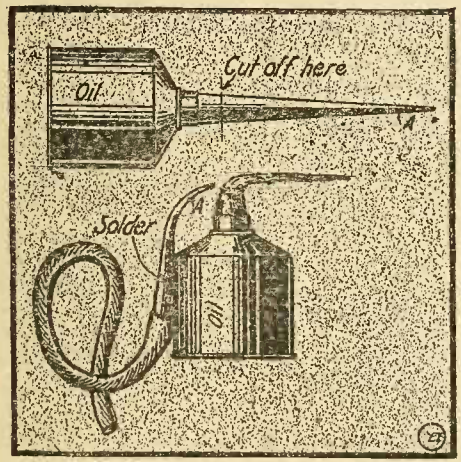
Simply Fill a Fan Grease Cup with Wood Alcohol, Insert a Wick in the Hole, and You Have a Serviceable Little Spirit Lamp for Light Soldering.

It will burn for one hour. This lamp can be used for numerous purposes, such as removing enamel from enameled wires, et cetera.

A small brass tube can be easily soldered to the cup for the purpose of providing a blast of air and a side-wise concentrated flame tip, by blowing through the tube. The upper end of the tube must be closed, and a tiny hole drilled in it—about No. 64 drill.

A HOME-MADE BLOW TORCH.

A good blow torch for the purpose of soldering wire joints and numerous other things may be made as follows: Obtain an oil can similar to the one shown in the sketch with a rather long spout. Cut the spout off about half an inch from the top of the can. Next curve it as shown and attach to the larger end a small rubber tubing about 1½ feet long. Solder the spout



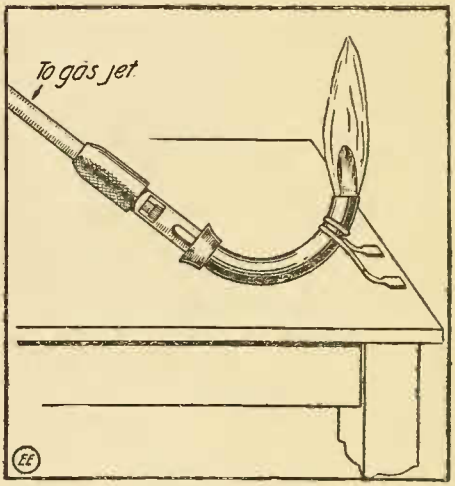
Blow Torch Made from Oil Can.

to the side of the can and pinch the small end of it together a trifle, in order to give a better draft. Place a wick in the can and some alcohol. When using, light the wick and blow in the tube, which will produce a very hot flame.

A HOME-MADE GAS TORCH.

Here is described how to make a gas torch. First two pipes are procured, one 3/16 and one ¼ inch in diameter and about 8 inches long.

I then drilled a hole in the quarter inch pipe and bent it as shown in drawing and set the other pipe into it. The handle is of oak with the edges rounded and two holes drilled through it to fit each pipe. The air and gas supply come through rubber hoses. A very good air compressor is

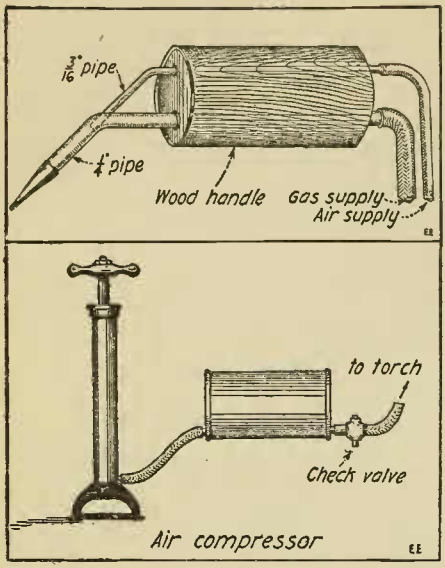


To Make This Gas Blow Torch You Will Require a Bicycle or Other Small Pump, a 1 to 5 Gallon Can, and Two Lengths of Rubber Tubing to Lead the Gas and Comprest Air to the Torch Handle.

made out of a bicycle pump and a one gallon can; the gas may be taken from the gas service pipes or from a carbid generator.

BUNSEN BURNER.

An old gas burner, the kind that is used with a mantle, and which can be purchased for a few cents is procured. It is bent in the shape depicted in the illustration. By wrapping some heavy wire around the tube it can be made to stand in an upright position. This burner will take the place of those costing 50 cents or more.



Cheap Bunsen Burner Made from Gas Mantle Parts and a Piece of Wire.

SMALL SCREWS.

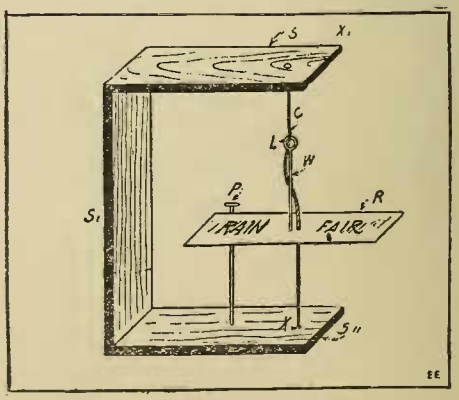
The length of the smallest screw ever made is .028 of an inch, its diameter .026 of an inch, weight .012 of a grain. There are 360 threads to the inch and it takes 582,333 of these screws to make a pound.

A HOME-MADE HYGROMETER.

The *Hygrometer,* as we know, is an instrument for measuring the quantity of moisture in the atmosphere. It depends on the property possest by some substances, of readily absorbing moisture from the air, and being thereby changed in dimensions or in weight. Of this kind is the Hygrometer of Saussure, in which a hair, that will expand and contract in length accordingly, as the air is more or less moist, was made to move an indicator.

A simple Hygrometer, which could foretell the approach of a rain sixteen to twenty-four hours in advance will come in quite handy. A description of the instrument follows: Referring to sketch: S, S′ and S″ form a wooden support. (The experimenter can construct this to suit himself, some preferring to make a more fancy one than others,) W, is a small, stiff wire, about 3″ long and attached to a thin piece of wood which has been planed down to 3″ by ½″ by 1/16″. A cat-gut string is then procured—C. (Such as the "A" string on a violin.) This string is fastened securely at the top of the support, by boring a small hole, inserting the string and then plugging the hole with a small wooden plug. X′ The free end of the wire, before described, is then bent into a small loop about ¼″ diameter and is shown at L.

Next we thread the string through the loop and give it one-half turn around the wire. It is then led through the indicator "R" by boring a small hole of slightly larger diameter than the cat-gut. The hole should be bored as near as possible to where the wire is secured to the indicator. The cat-gut string should now be pulled taut and plugged in the bottom of the support at "X."



A Home-Made "Hygrometer" Constructed from a Piece of Suspended Wood, Shaved Down Thin, Through Which Runs a Piece of Cat-Gut.

A small nail P is then driven into the support S to act as a stopping point. Its duty is to allow the indicator to swing about in one direction only. "Fair" and "Rain" may now be painted on the indicator and our mechanical weather-man is completed.

The builder may desire to construct a more elaborate support which he can do by making a small wooden house and decorating it with pieces of bark to give a novel log-cabin effect. However, the front must be constructed open to allow the indicator to swing around. The instrument is then placed in some open but sheltered place and is ready for use.

The action is as follows: When the cat-gut is taut it exerts a twisting motion on the wire and tends to twist the end of the indicator marked "Rain" against the stopping point "P." When there is a great deal of moisture in the atmosphere the cat-gut string will become slack and allow the end marked "Rain" to swing half way around.

In this way we can all become modern weather prophets.

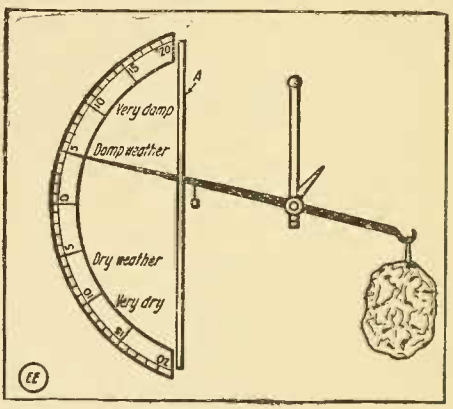
HOW TO MAKE A HYGROMETER.

The hygrometer is an instrument to measure the degrees of dryness or moisture of the atmosphere. There are various kinds of hygrometers; for whatever body either shrinks or swells by dryness or moisture, is capable of being formed into an hygrometer, such as woods of most kinds, particularly ash, deal, poplar, etc. The following is the most lasting and convenient mode of construction for an instrument of this description.

Take a very fine balance, and place in it a sponge, or other body which easily absorbs moisture, and let it be in equilibrium with a weight hung at the other end of the beam. If the air becomes moist, the sponge, becoming heavier, will preponderate; if dry, the sponge will be raised up.

This balance may be contrived in two ways, by either having the pin in the middle of the beam, with a slender tongue, a foot and a half long, pointing to the divisions of an arched plate, fitted on it, or the other extremity of the beam may be so long, as to describe a large arc on a board placed for the purpose.

To prepare the sponge, it may be necessary to wash it in water and, when dry, in water or vinegar, in which sal ammoniac or salt of tartar has been dissolved and let it dry again; then it is fit for use. The



A Simple Hygrometer Which Can Be Made at a Cost of a Few Cents, from a Sponge, a Paper Scale and a Lightly Pivoted Lever.

instrument can be hung against the wall; and, in that case a bit of steel, as at "A," should be placed before the needle, to keep it straight.

COINS FOR WEIGHTS.

In an emergency, ordinary coins can be used as weights. The weights given in the following table are near enough for all the usual purposes.

Dime weighs	40 grains
Cent weighs	50 grains
Nickel weighs	80 grains
One-quarter Dollar weighs	100 grains
One-half Dollar weighs..	200 grains
One Dollar weighs.....	400 grains

By simple addition and subtraction a great many different weights can be made with these coins. For instance, to obtain a weight of 20 grains, place a nickel on one side of the scales and a quarter on the other, and then add enough of the chemical to balance it.

THERMOMETER SCALES.

Of the three scales in general use, the Centigrade scale [also called Celsius] is the most rational one and the one used in all scientific research and international literature; it is also used exclusively in most of the European countries. The zero point is the melting point of ice, and the 100° point is the boiling point of water. The Fahrenheit scale is used in the United States and England; on this scale the melting point of ice is exactly 32°, and the boiling point of water is 212°. The Reaumur scale is in limited use in Germany; it has the same zero point as the Centigrade scale, but the boiling point of water on this scale is exactly 80°.

TABLE SHOWING THE COMPARISON OF THE READINGS OF THERMOMETERS.

C = Centigrade, or Celsius. R = Reaumur. F = Fahrenheit.

C	R	F	C	R	F
— 30	— 24.0	— 22.0	23	18.4	73.4
— 25	— 20.0	— 13.0	24	19.2	75.2
— 20	— 16.0	— 4.0	25	20.0	77.0
— 15	— 12.0	+ 5.0	26	20.8	78.8
— 10	— 8.0	14.0	27	21.6	80.6
— 5	— 4.0	23.0	28	22.4	82.4
— 4	— 3.2	24.8	29	23.6	84.2
— 3	— 2.4	26.6	30	24.0	86.0
— 2	— 1.6	28.4	31	24.8	87.8
— 1	— 0.8	30.2	32	25.6	89.6
Freezing point of water			33	26.4	91.4
0	0.0	32.0	34	27.2	93.2
1	0.8	33.8	35	28.0	95.0
2	1.6	35.6	36	28.8	98.8
3	2.4	37.4	37	29.6	98.6
4	3.2	39.2	38	30.4	100.4
5	4.0	41.0	39	31.2	102.2
6	4.8	42.8	40	32.0	104.0
7	5.6	44.6	41	32.8	105.8
8	6.4	46.4	42	33.6	107.6
9	7.2	48.2	43	34.4	109.4
10	8.0	50.0	44	35.2	111.2
11	8.8	51.8	45	36.0	113.0
12	9.6	53.6	50	40.0	122.0
13	10.4	55.4	55	44.0	131.0
14	11.2	57.2	60	48.0	140.0
15	12.0	59.0	65	52.0	149.0
16	12.8	60.8	70	56.0	158.0
17	13.6	62.6	75	60.0	167.0
18	14.4	64.4	80	64.0	176.0
19	15.2	66.2	85	68.0	185.0
20	16.0	68.0	90	72.0	194.0
21	16.8	69.8	95	76.0	203.0
22	17.6	71.6	100	80.0	212.0
			Boiling point of water.		

To convert *Centigrade* into Fahrenheit:

Degrees Centigrade multiplied by 9, and divided by 5, then add 32.

Example — 80° C.×9÷5=144+32=176° F.

To convert *Fahrenheit* into Centigrade:

Subtract 32 from the number of degrees Fahrenheit, then multiply by 5, and divide by 9.

Example — 100° F.—32=68×5÷9=37.8° C.

To convert *Reaumur* into Fahrenheit:

Degrees Reaumur multiplied by 9, divide by 4, and add 32.

Example — 16° R.×9÷4=36+32=68° F.

To convert *Fahrenheit* into Reaumur:

32 subtracted from degrees Fahrenheit, multiply by 4, and then divide by 9.

Example — 95° F.—32=63÷9×4=28° R.

The above table and formula for converting the different degrees to another will be found very useful, especially when, for instance, you have facilities to work with a Centigrade thermometer, and the Fahrenheit degree is mentioned.

(See also Appendix.)

HANDY APPARATUS FORMED ENTIRELY OF WIRE.

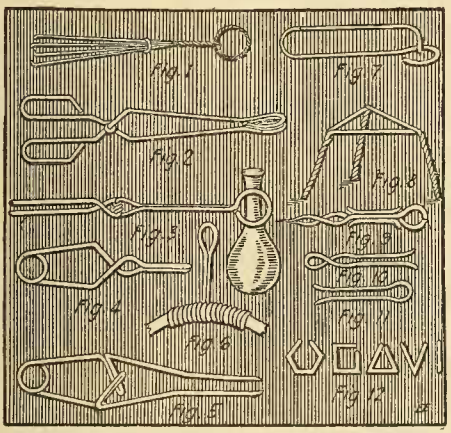
As shown in the accompanying sketches a number of useful articles of constant service to the experimenter may be constructed of ordinary wire with the aid of a few common tools.

Obtain a few feet of galvanized iron wire, or if the item of expense is not important, brass wire; 3 or 4 gage numbers are required, depending upon the size of the apparatus to be constructed.

Provide a pair each of flat, round and cutting pliers, some wood sticks about the dimensions of a lead pencil, and a few short lengths of tubing to aid in bending and forming the wire; after a few experiments you will be able to determine the size of the wire best adapted.

Cork Puller.

Figure 1.—Cut two pieces of wire the desired length, twist together and form ring. Now twist the four ends to about one-third the length of the shank. Make separately a ring of sufficient size to fit loosely over the shank, cut wires of shank to same length and bend ends to a right angle about ⅛ inch. Slip on the ring and spring the four ends apart to keep ring in position. The completed article will be found of service in removing corks which have fallen into the container, and



Numerous Handy Devices for Holding Test Tubes and the Like Can Be Easily Constructed from Wire with a Little Ingenuity.

by placing a piece of cotton in the jaws a most useful instrument is formed for the cleaning and drying of test tubes.

Holders.

Figures 2 and 3.—Follow outline of sketch to obtain good results. Twist wires together 3 or 4 times, allowing but very little play. Bend the four ends at a straight angle and form the ring at the end of tool by bending wire around a rod of the required size.

Spring Holders.

Figures 4 and 5.—Use very thick and springy wire; will be found of service in holding articles to be soldered or cemented.

It will be observed from sketch that device in figure No. 4 holds by itself, while the reverse is true of No. 5 design. The ends of these holders can be made pointed or flattened as preferred.

Figure 6.—Holder for rubber tubes. Obtain a piece of thin wire. First bend it in two, making a loop to allow a hook to hold it in place. Then wind wire around a rod of proper size. Slip tube through spiral so formed. This device will not permit tube to kink or bend at an angle sufficient to kink or to fracture.

Figure 7.—Holder for articles to be soldered or heated. The light pressure obtained by allowing the straight bend to pass a little through the ring will be found sufficient to hold the articles in a position convenient for operation.

Figure 8.—Tripod to support retorts. This article is formed by twisting three wires together forming a stand as shown in sketch.

Figure 9, 10 and 11.—Battery connectors. Figure 10 can be fastened to table by putting a screw or nail through ring at its end. In the event of the contact jaws becoming loose they can be adjusted by drawing the ends closer together. The line wires can be soldered to the connectors, and if desired the connection on figure 11 can be covered with insulating tape.

Figure 12.—Very light weights. Each bend increases 1 centigram or 1 decigram, varying according to the size of wire used.

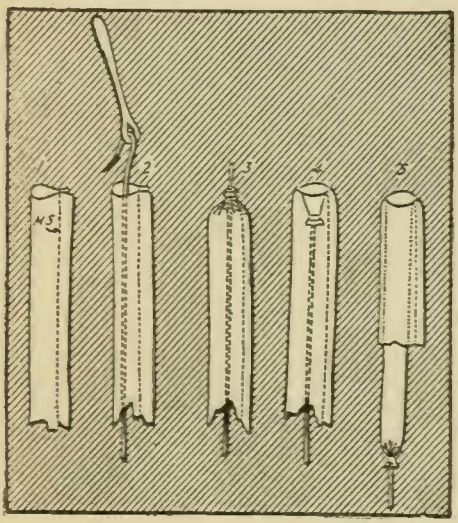
MAKING FLEXIBLE-CORD COVERS.

Cut a strip of cloth, any kind and any length, half an inch wide, fold it lengthwise as in Fig. 1, with the *wrong* side out if there is a wrong side, and sew a line of machine stitch down the side as shown. Don't try to sew too near the edge.

Next, run a piece of stout twine through with a tape needle, as shown in Fig. 2. When through, gather the upper edge of your cloth tube together, as in Fig. 3, and

sew it to the piece of twine. Don't try to tie your twine, as that makes rather too large a knot to start through easily.

Now hold the other end of the twine in one hand (or if your tube is very long, tie it to a door-knob) and with the other hand



Pst! An Alcove Secret! A Friend Tells Us How the Tailors Got the Seam Inside.

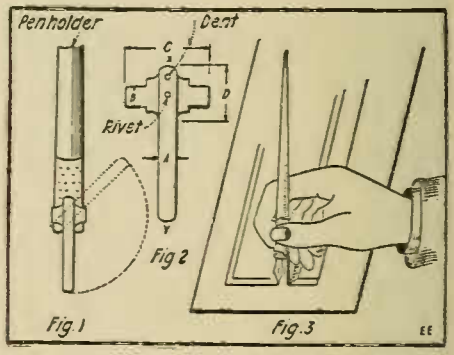
work the puckered end down inside, with a motion like pulling on a glove-finger, (Fig. 4). Once started, there is not the slightest difficulty.

Fig. 5 shows the end of the operation, with the completed tube coming through, right side out, with the seam concealed, and with the extra flap serving to stuff the tube and make it plump and round. The conductor, composed of a dozen braided wires from your old Ford secondary, is run through with the tape needle, and there you are. Cost per yard, exactly $0.00.

I have a particular affection for this invention because I had a dollar on it once —about the only dollar I ever did wring from Science. The stenographer was aiming to replace a broken belt-loop on her velvet coat, and was stumped to know how the tailor had got the seam inside. Recognizing my old process, I was explaining it to her, when the boss came in and bet me a dollar I couldn't do it. The girl made the tube, I ran the string, manipulated a second, and "Psst!" thru it went, like a rat two jumps ahead of the feline. The boss handed over his dollar, while the stenographer said something which in polite ladies' language is equivalent to—"Well, I'll de d——d!"

HOW TO DRAW LINES WITH WRITING PEN.

Those who have tried to draw straight lines with a writing pen and rule, nine times out of ten have obtained an unsightly blot for their labors.



To Draw Straight Lines Is Not So Simple a Matter as You Think, but with a Little Help You Will Soon Attain Perfection

Neat and clean-cut lines may be drawn with the use of the following device. The thickness of the lines will depend on the kind of pen points used. The guide arm (A) may be constructed of brass, although steel is preferable in this case. The band (BD) should be made of spring steel, a piece of spring of an old clock would be sufficient. All that is required of the material would be that it should hold its form and not be easily bent.

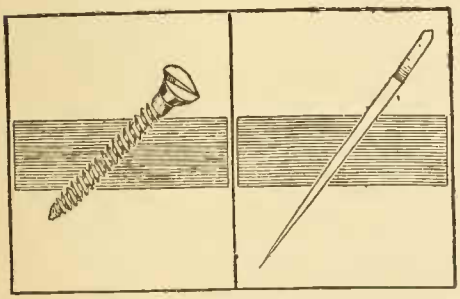
A rivet is fixt to hold the guide arm and band together. Make a dent with a center punch above the rivet both in the arm and band to hold the former in place, as in the case of the extension or commonly called zigzag rule. No dimensions are given, although for an ordinary pen-holder (A) could equal 3-16", B=¼", C=1⅛", D=½", and XY=1¼".

A desirable feature of the device is that the guide arm may be folded so that the pen may be dipt in the ink bottle as shown in Fig. 1, and in that position it can be used as a clip to hold it in the pocket also. The band may be constructed in any design suitable to the maker.

DRILLS MADE FROM NEEDLES.

Having occasion to use many small drills, and not wishing to incur the expense of continually repairing old ones, I used the following trick:

I procured several sewing needles of the same diameter as the drill I needed. After breaking off the eye, I ground the needle slightly flat on both sides of the large end. I then shaped the flattened end according to the sketch. These drills will do good work and will not break so easily.



Now Don't Get All Mother's Needles. Remember She Has to Darn Your Stockings!—And You Can't Unscrew This Wood-Screw!

A WOOD SCREW WHICH CANNOT BE UNSCREWED.

Many times the experimenter has need of a wood screw which can be screwed into a piece of wood; but cannot be taken out. A screw of this kind can easily be made by taking an ordinary wood screw and filing down each side of the head, as shown in the illustration.

It will readily be seen that while it can be screwed into the wood, it cannot be unscrewed.

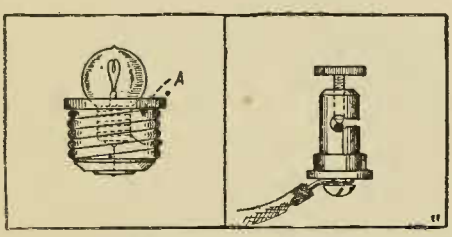
MAKING THE MOST OF A LITTLE SPACE.

It is most discouraging to have to spend half an hour finding tools and impedimenta before starting an hour's work in the evening. The remedy is to have a place for everything, and keep everything in its place. Also, keep them as compactly as possible. A good deal of extra room can be got out of an ordinary cupboard by the exercise of a little ingenuity. Things not often required should be kept on the top shelf. Perhaps there is still some space to spare. Then tack a piece of cloth or a large handkerchief inside the top of the cupboard, and screw in a couple of brass screw hooks a few inches from the ends. Sew a brass ring to each of the free corners of the cloth and you have a sort of cradle in which many odd things may be suspended by slipping the rings over the hooks.

A dozen wooden soap or sugar boxes, stood one above another in a corner of the room, preferably in a recess, will do duty for a cupboard. Capital shelves can be made inside the boxes, using wood from the lids, while the whole structure can be effectually disguised during the daytime by covering it with a piece of dark colored material. Extra room can be made by fixing hooks to the outside edges of the boxes for things that can be hung up, while other odds and ends can be dropt into cocoa tins and the like tacked to the sides of the boxes.

TEST CLIP MADE FROM BINDING POST.

For making contact with insulated wires take an old binding post and file the thumb screw to a point. Also cut a portion of one side out with a hack-saw as shown in the drawing. To make contact with an insulated wire, simply slip the wire in the slit in the side and force the thumb screw point through the insulation. This saves the time and bother of skinning the wire. It also may be used as a helix clip.



At Left: Standard Lamp Base Fitted to Miniature Lamp. At Right: Handy Test Clip Made From Binding Post.

FITTING A MINIATURE BULB TO STANDARD SOCKET.

First we need a broken Edison bulb, a miniature lamp and some sealing wax or paraffin. Then break all the glass from the bottom of the large lamp base. Now solder the two wires from the Edison shell to the rim and center of the miniature bulb. Heat some sealing wax and pour in around the shell and set aside to harden. This attachment will be useful to anyone who has a socket with a snap on the side or a pull-chain socket.

HOW TO TREAT STORED ACCUMULATORS.

Bearing in mind that the result desired is always the preservation of the accumulator plates, the advice always depends upon whether the owner desires to keep his accumulator in good condition with as little disturbance as possible of its working state, or whether he desires to store it for a long period of time and does not object to the trouble involved in removing the acid and refilling again when the battery is to be put in use again.

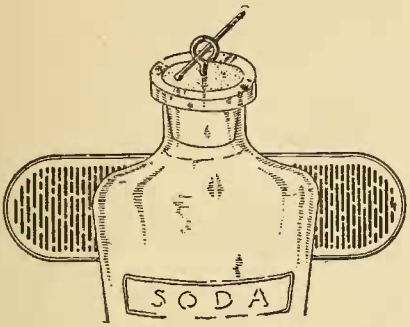
There are two methods, the dry system and the liquid system, the former being the better. For the dry system give the battery a thoroly good charge in order to bring all the plates into a satisfactory state. Then remove the acid, fill up again with pure water, discharge the battery for a few hours until the voltage has fallen 10 per cent, and then immediately empty out the water, let the cells drain as much as possible, remove the terminals, wash away any traces of acid on the top covers, put a little vaseline on the terminal stems and all connections, and store in a place free from dust.

The object of discharging after the water has been added is to avoid heating of the negative plates when the cells are dry. The object of putting water in the cells for the discharge is for the purpose of thoroly removing the acid in the pores of the plates. On no account leave the water in the cells, whether charged or discharged, as they will rapidly sulfate if you do. Advice is sometimes given to fill cells with water and leave it in. This is absolutely wrong.

The liquid system is as follows:—See that the plates are well covered with acid, but keep it below the lead connecting bars inside the cells. Charge up the battery until it is thoroly well charged. Remove the terminals and vents, carefully clean the tops of cells, vaseline all metal parts and store in the dark, with protection from dust. A periodical charge is beneficial, but not always necessary; this depends upon the condition of the battery when stored, the type of plates, and the amount of loose sediment there may be in the cells. If the voltage is found to be low after a few weeks, it is a sign that the battery requires attention.

EMERGENCY CORK SCREW.

Recently I had occasion to open a bottle and, not having a cork extractor, very simply accomplished my purpose by using an ordinary screw eye in combination with



A Cork Screw in a Jiffy—Simply a Nail and a Screw Eye Do the Trick.

a nail, as shown in the drawing. The use of the latter provided a better means both for turning the screw and pulling the cork out.

RECIPES FOR KILLING FLIES.

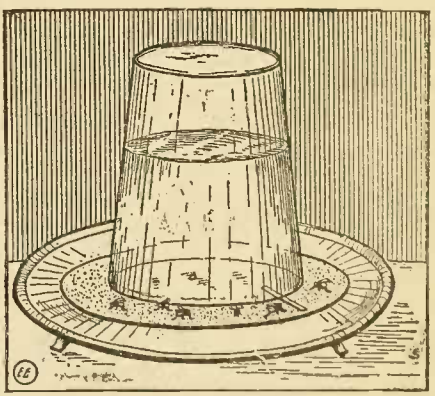
The United States Government makes the following suggestion for the destruction of house flies: Formaldehyde and sodium salicylate are the two best fly poisons. Both are superior to arsenic. They have their advantages for household use. They are not a poison to children; they are convenient to handle; their dilutions are simple, and they attract the flies.

Preparation of Solutions:—A formaldehyde solution of approximately the correct strength may be made by adding 3 teaspoonfuls of the concentrated formaldehyde solution, commercially known as formalin, to a pint of water. Similarly, the proper concentration of sodium salicylate may be obtained by dissolving 3 teaspoonfuls of the pure chemical (a powder) to a pint of water.

A container such as shown below has been found convenient for automatically keeping the solution always available for flies to drink. An ordinary, thin-walled drinking glass is filled or partially filled with the solution. A saucer, or small plate, in which is placed a piece of *white* blotting paper cut the size of the dish, is put bottom up over the glass. The whole is then quickly inverted, a match placed under the edge of the glass, and the container is ready for use. As the solution dries out of the saucer the liquid seal at the edge of the glass is broken and more liquid flows into the lower receptacle. Thus the paper is always kept moist.

Other Simple Preventives:—Any odor pleasing to man is offensive to the fly and *vice versa,* and will drive them away.

Take five cents' worth of oil of lavender, mix it with the same quantity of water, put it in a common glass atomizer and spray it around the rooms where flies are. In the dining-room spray it lavishly *even on the table linen.* The odor is very disagreeable to flies but refreshing to most people.



When the "Fly Season" Is With Us, the Non-Poisonous (to Humans) Wet Blotter Fly Annihilator Shown, Which Is Recommended by the U. S. Government, Should Prove Particularly Valuable.

Geranium, mignonette, heliotrope and white clover are *offensive* to flies. They especially *dislike* the odor of honeysuckle and hop blossoms.

According to a French scientist, flies have intense hatred for the color *blue. Rooms decorated in blue will help to keep out the flies.*

Mix together one tablespoonful of cream, one of ground black pepper and one of brown sugar. This mixture is poisonous to flies. Put in a saucer, darken the room except one window and in that set the saucer.

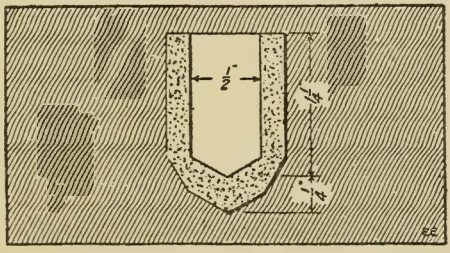
To clear the house of flies, burn pyrethrum powder. This stupefies the flies, but they must be SWEPT UP and BURNED.

Recipes for Stables, Barns and Out-of-doors:—Borax is especially valuable around farms and out-of-doors. One pound of borax to twelve bushels of manure will be found desirable as a poison without injuring its manurial qualities on farm stock. Scatter the borax over the manure and sprinkle with water.

Lye, chlorid of lime, or copperas (sulfate of iron) dissolved in water, crude carbolic acid, or any kind of disinfectant may be used in vaults.

A HOME-MADE CARBON CRUCIBLE.

It is often that the experimenter desires to melt a small quantity of metal and mould it into a certain shape, or he might want to mix a special amalgam. But he is stopt by the lack of some suitable container or crucible; and he does not want to buy



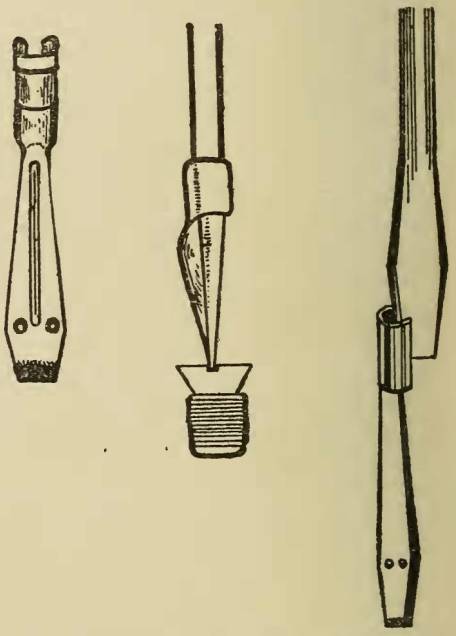
Make Your Own Crucibles and Build an Electric Furnace to Make Diamonds.

one. Herewith are given the directions for making a crucible that will stand a very high temperature.

From a round battery carbon cut a piece 1½" long. From the top drill a ¼" hole 1¼" deep. Round off the bottom and the result will be a good carbon crucible. The contributor has melted iron in a crucible of the above design. By using a dry plaster of Paris mould the metal may be cast into the desired shape.

HOLDING ON TO THE SCREW.

A clever little device has recently been put on the market which should save the motorist's or electrician's vocabulary of



One of the Latest Devices for Mechanics Is an Attachment for Holding On to Small Screws in Inaccessible Places.

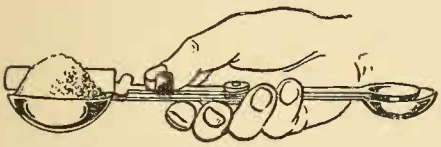
swear words from being overworked. The device is made of specially tempered crucible steel and may be slipt on any screw driver. Once in place it serves to hold a screw firmly on the end of the screw driver till it is well started into its required position.

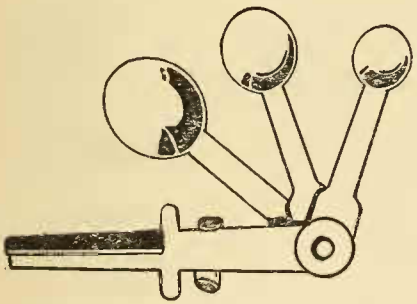
Such a device should prove particularly helpful in fastening parts of machinery

which are hard to get at and which require the use of small sizes of screws.

A SELF-LEVELING MEASURING SPOON.

A set of measuring spoons with a self-leveling attachment is a recently pat-





A New Measuring Spoon Which Saves Much Time and Many Poor Mixtures. It Always Levels Off the Spoon Even and Is Graduated as Indicated.

ented invention which reduces to simplest form exact measurements while using the fewest possible utensils.

The set consists of three spoons from one-fourth to a teaspoon, all riveted to a cleverly contrived bar so that the unused spoons form a handle, while the thumb easily pushes the bar across the spoonful of material, thus securing without using another article—usually a knife—the level spoonful now specified in culinary recipes and other formulae.

"THE SYNTHETIC PRODUCTION OF RUBIES."

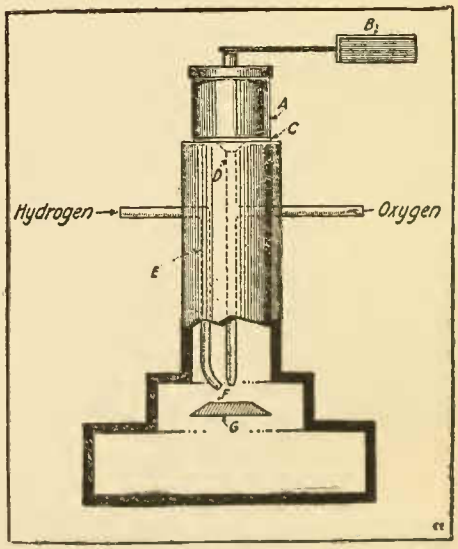
During the last few years, practically all of the beautiful minerals of the corundum family have been produced synthetically in the laboratory. These artificial gems are identical in beauty, hardness, and chemical composition to those obtained from the mines. The accompanying diagram shows a furnace commonly used in producing the gems.

The operations are as follows:

A trace of chrome alum is added to a solution of common alum, the chrome alum being the coloring constituent.

Then ammonia is added and a gelatinous precipitat of the hydrates of alum and chrome is formed.

This precipitat is filtered off, evaporated to dryness and calcined in a furnace at a temperature of 1000° F. into an ultimate mixture of alumina and chromic oxid. The



Do You Know That Rubies Are More Valuable Than Diamonds? With This Furnace You can Make 'Em by the Pound. Don't Forget to Send Us a Few Pounds!

proportion in which these two chemicals occur in the ruby are:

Alumina 98%

Chromic Oxid. 2%

The mixture is then ground into a powder and placed in the hopper "A." "B" is an electrical tapper which shakes the powder through the sieve "C" into the tube "D." Through this tube the oxygen is supplied through the tube "E." The two gases are ignited at "F." "G" is a platform made of a highly refractory substance against which the flame strikes and on which the ruby is formed in a pear-shaped mass. The rate of flow of the powder and the temperature of the oxy-hydrogen flame must be regulated very carefully. When a head of sufficient size has formed the heat is gradually lowered so that the gem may be free from great stresses. When it has cooled, it is broken off the base and sent to the cutter who finishes the gem.

It is important that the ingredients used in producing the minerals be of the purest obtainable.

A "COST-LESS" NIGHT LAMP.

Obtain a small bell-ringing transformer that gives three voltages on the secondary, also a 14 volt Christmas tree lamp.

Then purchase a wall socket that will hold this bulb and connect the wall socket to the 14 volt terminals of the transformer. Having connected the transformer to the 110 volt A.C. current, insert the bulb. The result is a light that illuminates the whole house sufficiently at night. You can operate this same bulb every night, all night long, for years. The amount of current used scarcely causes the meter to move.

ELECTRIC WARNING FOR POISON BOTTLES.

This instrument is used in two ways as follows: The clamps 5 and 6 in illustration serve to fasten bottle to avoid its falling from shelf, and also to notify an ignorant person of the presence of poison. Proceed to first construct upright, A, 2″ high, 1½″ wide, and ½″ thick. Fasten block to shelf by screw 1. At any height put in binding posts on block, as shown in figure. Construct clamps 5 and 6 out of old clock springs heated, bent in above design and retempered. These should be constructed according to the circumference of bottle, leaving ¼″ between X and Y.

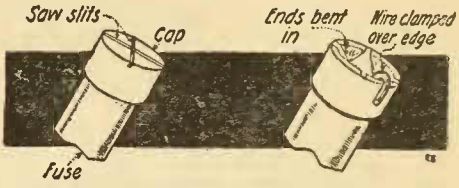
When the Poison Bottle Is Removed From the Contact Strips, They Spring Together, Closing an Alarm Bell Circuit.

Connect spring arms at posts and connect posts to batteries and warning bell as indicated in figures. When at night, anyone removes the bottle the springs come together and thus make contact accordingly. The bell rings as warning of poison.

THIEF CATCHER.

Very often people are bothered by nocturnal cherry thieves. Hence this clever trap was made by annealing one end of a clock spring and puncturing it with two screws. Next screw it to a wooden base so that the free end is clamped to the base with a little pressure. Then screw a piece of metal on the base so that the spring rests on it. The spring and metal are connected so as to close a bell circuit. A small block of

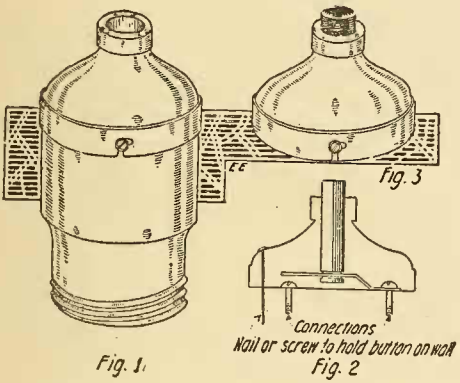
non-conducting material is placed between the spring and metal contacts and a thread tied around the block, so that the pulling of the thread will pull the block out and cause the circuit to be closed. The thread encircles the tree and the thief walking into it rings the bell. This device costs practically nothing and may save many dollars worth of fruit and poultry.



Renewable Fuse Easily Made.

A HOME-MADE PUSH-BUTTON.

Below is a description and illustration of a home-made push-button.



Here's a Nifty Brass Push Button Made from the Shell of a Discarded Lamp Socket.

The top part of an old electric lamp socket is used for the case, as shown in Fig. 1, and the assembled button is shown in Figs. 2 and 3, which explain themselves.

A SIMPLE RENEWABLE FUSE.

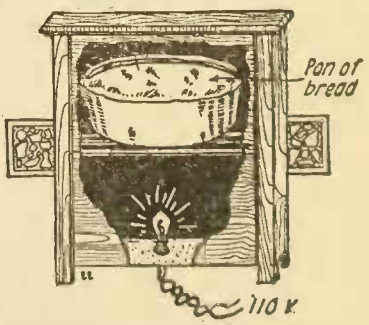
Amateurs utilizing large amounts of current usually have trouble with their fuses blowing out. A method that makes this occurrence less expensive is to make use of the so-called *renewable fuses.*

Cartridge fuses may easily be arranged so that new pieces of fuse wire may be put in very easily. A fuse of the proper size as regards the clips is obtained and the brass caps slit with a saw as shown in the illustration, thus cutting the ends of the caps into four pieces. The pointed ends are bent in and in this manner the caps are fastened permanently to the fiber tube. The asbestos filling is removed and the tube cleaned out.

To renew such a fuse it is only necessary to run a length of wire of the proper size through the tube and bend the ends of the wire around the ends of the tube, thus making connection to the brass caps. When the fuse blows the melted metal will not spatter, since it is confined by the tube. Corks may be placed in the ends of the tube to prevent undue splashing of the hot metal, but one of them should have a V-shape slot cut in the side to act as a vent for the gases.

ELECTRIC BREAD RAISER.

A box of suitable size is fitted with air tight cover and a 32 candle-power carbon lamp screwed in the bottom of the box. The shelf that the bread rests on is made of

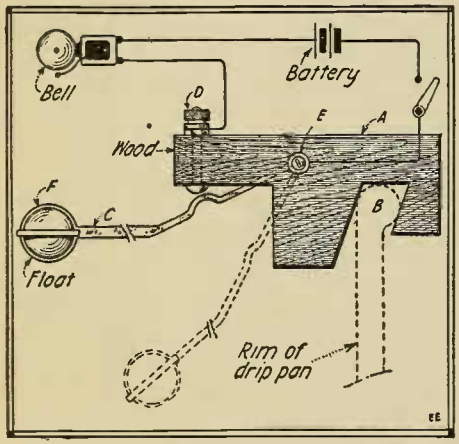


An Electric Bread Raiser—Simply Place a 32 C. P. Incandescent Lamp Under the Pan of Bread and Watch the Results.

slats, spaced about two inches apart. This is done to allow the heat to radiate freely in the box, when the bread is placed in it. The method has worked out well.

TELL-TALE FOR REFRIGERATOR DRIP PAN.

This tell-tale for an ice box drip-pan consists of a piece of hard wood or fiber cut into the form (A). A piece of No. 14 copper wire is bent into the form (C). This form is allowed to turn on pivot (E), which is a current carrying part of the circuit. When the pan is full of water, the form (C) floats up by means of a piece of wood (cork is good) attached to the end. The copper wire makes contact with (D), and the bell rings, indicating that the pan is full. The notch (B) makes it possible to take the device off when emptying the pan.



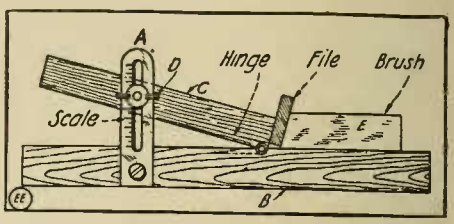
Simplicity Is Stamped All Over This Home-made Refrigerator Drip-pan Alarm. It Costs But a Few Cents to Make and Will Save Your Carpets and Hard-wood Floors.

DEVICE FOR SHAPING NEW BRUSHES FOR COMMUTATORS.

The drawing shows a simple device for shaping new brushes for commutators of motors and dynamos. The strip A is fastened to the board B, while piece C is hinged to B.

D is a wing nut and screw, which can be clamped to keep the piece C at its adjusted angle.

The old brush is laid on as shown at E, and C adjusted to the nearest angle. The



A Time-saving Carbon Brush Facing Device.

file is placed on B. The new brush is held against B bearing against the file. This device roughs out the brush to approximately the right shape. The clamp strip A may be graduated to correspond with different angles.

After beveling off the brushes in this way to approximately the correct angle, they are placed in the brush holders and shaped to fit the commutator curve accurately by pulling a piece of sand-paper back and forth under the brush. Hold down on both ends of the sand-paper—not up.

POISON PREVENTER.

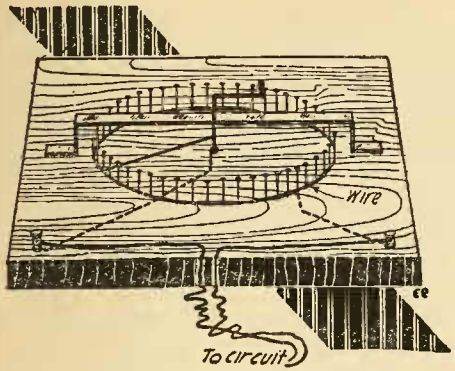
The following will be found a useful prevention from taking poison by accident: In the cork of the bottle insert some pins so that they extend above the cork slightly and are thus exposed. Cover the cork with these except a small space so that the fingers can hold the cork without being pricked. The idea is that when a person takes hold of this bottle in the dark they invariably will be pricked by the pins, which warns them that the bottle contains poison.

TO POISON RATS.

Mix together 2 ozs. of carbonat of barytes with 1 oz. of lard and lay it in their way. Also put a dish of water near, as it causes great thirst and as soon as they drink they die instantly.

SIMPLE CIRCUIT INTERRUPTER.

Small nails are driven in a board one-half an inch apart and connected together

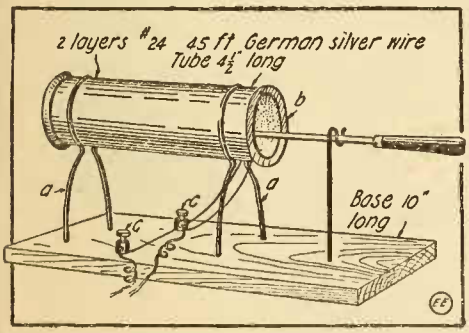


Simplest Circuit Interrupter Formed of a Ring of Nails, Against Which a Brass Spring Mounted on a Crank Is Turned.

by wire. A crank pivoted in the center has a spring brass strip soldered to it. On turning the crank fast or slow, the circuit is interrupted.

ELECTRIC SOLDERING IRON HEATER.

The tube here shown is made of sheet iron or steel bent around a 1¼-inch pipe.



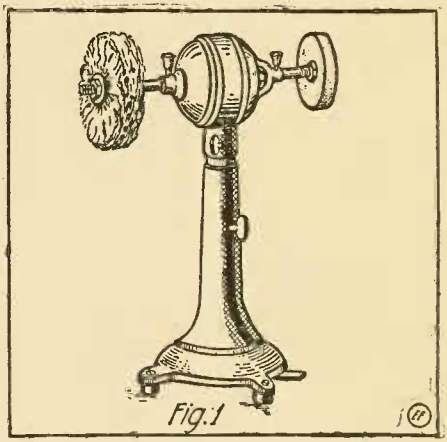
Electric Heater for the Soldering Iron, Comprising a Metal Tube Wound with Several Yards of Resistance Wire.

Remove it and bend up the edges about ¼ inch to hold on the winding and insulation. First wind two layers of mica around the tube, then one layer of No. 24 German Silver resistance wire, then two more layers of mica and another layer of wire. The total length of wire is 45 feet or so, as found by experiment. These are brought out to the binding posts and connected to the 110 mains. This is a fine heater, heating the iron in 1½ to 2 minutes and will last a long time if properly handled.

CONVERTING ELECTRIC FAN INTO BUFFER AND GRINDER.

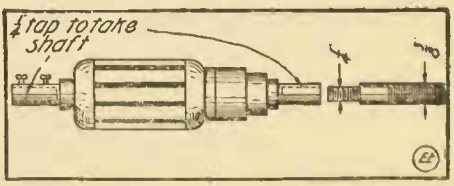
An ordinary electric fan may be easily converted into a buffer or grinder by drilling both ends of the armature with a number 6 drill, then tap it with a ¼-inch tap.

Take two pieces of ⅜-inch round iron, 4 inches long, and turn down about 1 inch on one end so as to cut a ¼-inch thread.



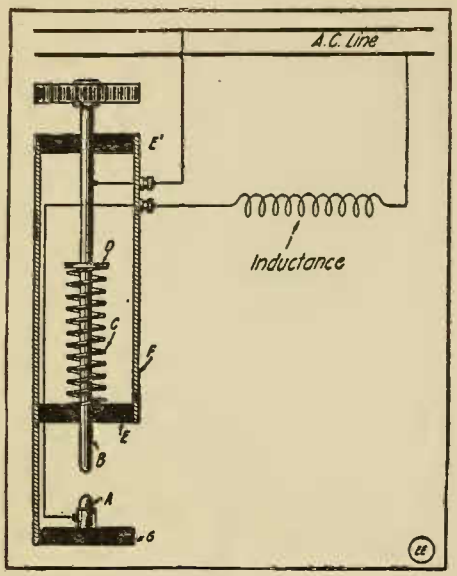
Converted Fan-Motor Serving as Buffer and Grinder.

The ¼-inch end is to fit in the armature shaft. On the other end a ⅜-inch thread is to be cut to take buffer and lock nuts. Two set screws are used on each side to keep buffer and wheel from loosening. The same work is performed on the other end of the shaft or an emery wheel may be used. This makes a very handy machine, suitable for grinding, buffing and polishing small instrument parts.



How Motor Shaft Is Extended by Threaded Sections at Either End.

AN ELECTRIC GAS LIGHTER FOR THE "LAB."



This Electric Gas Lighter Will Be Found a Distinct Convenience in Every Shop and Laboratory. Use an Iron Core Inductance On A. C. Circuits and a Resistance Coil On D. C. Circuits.

An electric gas lighter is not only a necessity but a convenience, especially in laboratories and such places, where gas is turned on and off at frequent intervals. The sketch shows how one was constructed with a few tools and in a very short length of time. The casing (F) is of hard rubber or fiber sawed as shown in sketch; the bushings (E) and (E') are also hard rubber or fiber, but can be made of impregnated hard wood. Spring (C) is to keep the movable electrode separated from the stationary electrode (A); (D) is a clamp around the movable electrode to hold the spring in its proper place.

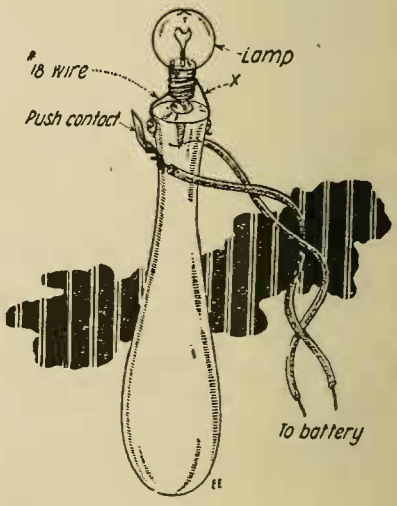
The wires leading to the line and inductance are flexible cords and may be brought out to small terminals on the side of the casing.

The inductance can be varied by the number or turns required for different cycles; the inductance used by the writer was obtained from an old A. C. arc light but one may be easily constructed by winding a number of turns of wire around a soft iron core.

A SIMPLE TROUBLE LAMP.

Described below is a plan of a very simple trouble lamp.

As you will see by looking at the sketch, the bulb is connected to a round-head screw, which makes contact with the wire which runs into a hole in the handle. The socket for the bulb is made by winding wire around its base, and tacking each end to the handle. The push contact is made from a short piece of thin brass.



A Wooden File Handle, a Battery Lamp, and Some Wire—You Then Have a Handy Trouble Lamp. A Push Button Can Be Added if Desired.

Miscellaneous Formulas.

MARKING POISON BOTTLES.

A very convenient way to mark bottles containing poisons so that they can readily be distinguished in dark rooms or closets is to cut a piece of heavy, coarse sand-paper the size of the top of the cork and paste or glue the piece on the top of the cork or stopper of the poison bottle. As one's hand invariably comes in contact with the top of

Take a Disc of Sand-paper or Emery Paper and Glue It on Top of Your Poison Bottle Cork—a Cheap Yet Efficient Marker Which You Can't Miss in the Dark.

the cork in opening a bottle, this simple device will prevent mistaking a bottle containing poison for another.

TO REMOVE PAINT.

To remove paint without leaving any traces use ether on a piece of cheesecloth.

TO PRESERVE DEAD PETS.

One lb. of dry sulfate of aluminum, one-fifth of a quart of water and twenty grains of arsenous acid, well mixed. Inject this into all the vessels of the body and you can thus preserve cats, dogs, birds, fish, etc.

FULMINATING POWDER.

Mix together in a warm mortar one part of saltpeter, two parts sulfur. Place on the edge of a fire shovel and hold over the fire. It will turn black and explode with a loud report.

TO RESTORE THE ELASTICITY OF RUBBER.

Immerse the article in a mixture of water of ammonia, 1 part, and water 2 parts until the object recovers its former smoothness.

NO-GLARE HEADLIGHTS.

Paste a piece of ordinary paraffin paper on the inside of the glass. A light so fixt is lawful and gives a good driving light.

LITMUS PAPER.

This paper is prepared by boiling litmus, and steeping the paper in the liquid; this paper turns red when touched by acids.

ROSEWOOD COLOR

Boil in ½ gallon of water, 1 pound log-wood chips and ½ pound red sandalwood. Apply to the wood, then go over it with a mixture of asphaltum and turpentine.

Appendix.

POISON ANTIDOTES.

Poisons.	Antidotes.
(a) Acids.	
Oxalic	Chalk, whiting, or magnesia in water.
Nitric, Hydrochloric, Sulphuric	Bicarbonate of soda, or carbonate of magnesia, chalk; in emergency, plaster of the room beaten up in water.
Carbolic, Muriatic	White of egg well beaten up with water. A teaspoonful of mustard flour in a cup of hot water.
Nitro-Muriatic	Very thick lime water.
Acetic	Soap and water, lime, magnesia, milk, oil, thick gruel.
Carbonic	Fresh air, artificial respiration, friction.
Tartaric	Lime water, castor oil.
Chromic	White of egg in water. Mustard flour.
Prussic	Continuous and heavy douches of ice cold water over head and back. Mustard plasters on stomach and soles of feet. Prevent sleep.
(b) Metallic Salts.	
Acetate of Lead	Sulphate of soda or magnesia.
Bichromate of Potash	Magnesia and chalk. Emetics.
Nitrate of Silver	Common salt in water, followed immediately by emetic.
Preparations or compounds of Chromium, Antimony, Copper, Mercury, Zinc	White of egg in water. Teaspoonful of mustard flour in cup of hot water.
(c) Caustic Alkalines.	
Ammonia, Potash, Soda	Vinegar in water. Lemon juice. Oil. Demulcent drinks. Large doses of milk.
(d) Vegetable Poisons.	
Ivy	Saline laxatives. Apply weak lead water and laudanum, or lime water and sweet oil; or bathe freely with spirits of nitre.
Alcohol	Strong coffee. Douche. Stomach pump.
Belladonna	Stomach pump. Emetics. Coffee. Artificial respiration.
Digitalis	Stomach pump. Emetics. Tannic acid. Stimulants.
Mushrooms	Stomach pump or emetics. Castor oil. Warmth. Stimulants.
Opium, Morphine	Stomach pump or emetics, inhale ammonia. Douche. Artificial respiration.
Nicotine	Stomach pump or emetics; stimulants, tannic acid. Hot applications to skin; keep patient lying down.

POISON ANTIDOTES (Continued)

(e) Miscellaneous.

Ether, Petroleum, Benzine, Fruit Essence	Plenty of mustard flour in large quantity of hot water. Cold water douches. Fresh air. Prevent *absolutely* sleep.
Arsenic and all compounds	Stomach pump. Teaspoonful mustard flour in hot water. Teaspoonful dialyzed iron mixed with same quantity of calcined magnesia every five minutes for one hour. Then plenty of oil, or milk.
Chloroform	Stomach pump or emetic. Solution of carbonate of soda. Mustard to the heart.
Coal Gas	Mustard to the heart. Artificial respiration. Stimulants.
Iodine	Stomach pump or emetic. Starch.
Phosphorus (matches)	Emetic. French oil of turpentine. Copper Sulphate. Purgatives.
Snake Bite	Cauterization and ligature. Stimulants. Permanganate, liquor potassae, artificial respiration. Ammonia injection.

WEIGHTS AND MEASURES

METRIC SYSTEM.

In place of the complicated English system of weights and measures, chemists now use the very simple and convenient metric system. This system is based on the meter, which has a length of about 39.37 in. There are three principal units: the meter, the liter, and the gram—the units of length, capacity, and weight, respectively. Multiples of these units are obtained by prefixing to the names of the principal units the Greek words *deka* (10), *hekto* (100), and *kilo* (1,000); the submultiples, or sub-divisions, are obtained by prefixing the Latin words *deci* (1/10), *centi* (1/100), and *milli* (1/1,000). These prefixes form the key to the entire system.

In the following tables, the abbreviations of the principal units of these submultiples begin with a small letter, while those of the multiples begin with a capital letter. Chemists commonly use c.c. for cubic centimeter. The equivalents in the common units in use in the United States are given in connection with these tables.

MEASURES OF WEIGHT.

10 milligrams	=	1 centigram (cg)
10 centigrams	=	1 decigram (dg)
10 decigrams	=	1 gram (g)
10 grams	=	1 dekagram (Dg)
10 dekagrams	=	1 hektogram (Hg)
10 hektograms	=	1 kilokram (Kg)
1,000 kilograms	=	1 ton (T)

1 gram = 15.432 grains Troy or .03527 oz. avoirdupois.
1 Kilogram = 2.2046 lb. avoirdupois or 2.6792 lb. Troy.
1 Metric Ton = 1.1023 Ton of 2,000 lbs.

The *gram* is the weight of 1 cubic centimeter (c.c.) of pure distilled water at a temperature of 4° C.; the *kilogram* is the weight of 1 liter (1.) of water; the metric ton is the weight of 1 cubic meter (cu.m.) of water at 4° C.

MEASURES OF VOLUME.

1,000 cubic millimeters .....= 1 cubic centimeter (c.c.)
1,000 cubic centimeters .....= 1 cubic decimeter (cu.dm.)
1,000 cubic decimeters .....= 1 cubic meter (cu.m)

1 c.c. = .061023 cu. inch
1 cu.m. = 35.314 cu. ft. or 1.3079 cu. yd.

MEASURES OF CAPACITY.

10 milliliters .....= 1 centiliter (cl)
10 centiliters .....= 1 deciliter (dl)
10 deciliters .....= 1 liter (l)
10 liters .....= 1 dekaliter (Dl)
10 dekaliters .....= 1 hektoliter (Hl)
10 hektoliters .....= 1 kiloliter (Kl)

1 liter = 61.023 cu. in. or 1.0567 liquid qt. or .9078 dry qt.

The liter is equal in volume to 1 cu. dm.

EQUIVALENTS.

MEASURES OF LENGTH.

Metric	U. S. Measure
1 metre	39.3704 inches
1 decimetre	3.9370 inches
1 centimetre	0.3937 inches
1 millimetre	0.0393 inches
U. S.	**Metric**
1 yard (3 feet or 36 inches)	0.9143 meters
1 foot (12 inches)	30.40 centimeters

ENGLISH SYSTEM.

One United States gallon has a volume of 231 cu. in., and contains 4 qt., or 8 pt. The English Imperial gallon contains 277.46 cu. in., hence the English gallon is equivalent to 1.20032 U. S. gal.

A gallon of pure water at 62° F. weighs 133.37 oz. or 58,350 gr.; hence, 1 pt. of pure water at 62° F. weighs 16 2/3 oz., or a little over 1 lb. The measure termed a *fluid ounce* is a measure of volume, and not of weight, and is equal to 1/16 part of a pint or approximately the volume of 1 oz. of pure water.

One fluid ounce is equivalent to 29.57 c.c. and contains 455.86 gr. of water at 62° F. One gram is equivalent to 15.43 gr., and 1 oz. avoirdupois is equivalent to 28.34 gr.

The unit of dry measure is the *bushel* which contains 2,150.4 cu. in.

The avoirdupois pound contains 7,000 gr.

MEASURES OF WEIGHT (AVOIRDUPOIS).

437.5 grains (gr.) .....= 1 ounce (oz.)
16 ounces .....= 1 pound (lb.)
100 pounds .....= 1 hundredweight (cwt.)
20 cwt., or 2,000 lbs.....= 1 ton (T)

T.	cwt.	lb.	oz.	gr.
1 =	20	or 2,000	or 32,000	or 14,000,000

TROY WEIGHT.

24 grains (gr.) .....= 1 pennyweight (pwt.)
20 pennyweights .....= 1 ounce (oz.)
12 ounces .....= 1 pound (lb.)
1 lb. = 12 oz. or 240 pwt. or 5,760 gr.

DRY MEASURE.

2 pints (pt.) .....= 1 quart (qt.)
8 quarts .....= 1 peck (pk.)
4 pecks .....= 1 bushel (bu.)
1 bu. = 4 pk. or 32 qt. or 64 pt.

LIQUID MEASURE.

4 gills .....= 1 pint (pt.)
2 pints .....= 1 quart (qt.)
4 quarts .....= 1 gallon (gal.)
31.5 gallons .....= 1 barrel (bbl.)
2 barrels or 63 gallons.....= 1 hogshead (hhd.)

hhd. bbl. gal. qt. pt. gills
1 = 2 or 63 or 252 or 504 or 2,016. *

1 cubic foot of water at its maximum density 4° C., weighs 62.425 lb. and 1 gal. weighs 8.345 lb.

LONG-TON TABLE.

16 ounces .....= 1 pound (lb.)
112 pounds .....= 1 hundredweight (cwt.)
20 cwt., or 2,240 lbs.....= 1 ton (L.T.)

COMPARISON OF UNITED STATES AND METRIC SYSTEMS.

1 c.c. × .0338 = fluid oz.
1 c.c. × .608 = cu. in.
1 cu.m. × 35.315 = cu. ft.
1 g. × .0353 = oz.
1 gal. × 3.785 = liter
1 gr. (Troy) × .0648 = gram
1 kg. × 2.2046 = lb.
1 pk. × 9.08 = liter

1 liter × 1.0567 = qt. (liquid)
1 liter × .264 = gal.
1 liter × .908 = qt. (dry)
1 liter × .0353 = cu. in.
1 m. × 39.37 = inch
1 oz. (Troy) × 31.104 = gram
1 oz. (avoirdupois) × 28.35 = gram
1 qt. (liquid) × .946 = liter

TABLE OF DISTANCES.

A mile is .....5280 feet or 1760 yards
A league is ..... 3 miles
A fathom is ..... 6 feet
A metre is nearly ..... 3 feet 3⅜ inches
A hand is ..... 4 inches
A palm is ..... 3 inches
A span is ..... 9 inches

* LIQUID MEASURES.

A barrel holds ..... 31½ gallons
A hogshead holds ..... 63 gallons
A tierce holds ..... 42 gallons
A puncheon holds ..... 84 gallons
A tun holds .....252 gallons

PER CENT. SOLUTIONS.

A table giving the weight in grains (avoirdupois) of any chemical substance required to make a per cent solution from 1 per cent to 50 per cent based on the weight of one gallon of water at 40° F. = 8.33888 lbs. (avoirdupois) or one fluid ounce of water weighing 456.03 grains (avoirdupois).

For each fluid ounce of water take:

For a	1 per cent solution	4.66 Grains
	2 " " "	9.38 "
	3 " " "	14.10 "
	4 " " "	19.00 "
	5 " " "	24.00 "
	6 " " "	29.10 "
	7 " " "	34.30 "
	8 " " "	39.60 "
	9 " " "	45.09 "
	10 " " "	50.67 "
	15 " " "	80.48 "
	20 " " "	114.00 "
	25 " " "	152.00 "
	30 " " "	195.44 "
	35 " " "	245.56 "
	40 " " "	304.02 "
	45 " " "	373.10 "
	50 " " "	456.03 "

It should be noted that the above table applies to water; percentage solutions for other liquids would necessarily have to be figured on the weight of the particular liquid.

Percentage solutions are also sometimes made up from a saturated base. This method is incorrect unless it is so designated in giving the formula, that is, by stating in the formula saturated solution base. Such percentages are made by placing in the liquid used, more of the chemical than the liquid will carry in solution; this resulting solution is filtered to remove the excess chemical and then used as a base. For example, to make a 10 per cent solution, 10 per cent of the base is used and 90 per cent of the pure liquid or in other words, 1 ounce of the saturated solution to 9 ounces of the liquid.

CONVERSION OF MEASURE EXPRESSED IN "PARTS."

Sometimes a formula in an experiment is expressed in "parts;" for example, a formula may read: Use 1 part of nitric acid, 2 parts of potassium bichromate and 5 parts of water. All that is necessary would be to designate the exact quantity that the part represents; then, if one grain for solids and one minim for liquids should be used, the above formula would work out as follows: Nitric acid, 1 minim; potassium bichromate, 2 grains, and water, 5 minims. Of course, this can be multiplied to any proportion.

For further reference the following table will also be found very useful:

No. of parts	Grains	Minims	Grams, or c.c.
1	1	1	1
2	2	2	2
3	3	3	3
4	4	4	4
5	5	5	5
10	10	10	10
20	1 scr.	20	20
50	50	50	50
60	1 dr.	1 dr.	60
100	1 dr. 2 scr.	1 dr. 40 min.	100
250	½ oz. 32 grs.	3½ dr. 40 min.	250
500	1 oz. 62 grs.	½ oz. 10 min.	500
1,000	2¼ oz. 16 grs.	2 oz. 40 min.	1,000
2,500	5½ oz. 94 grs.	5 oz. 1 dr. 40 min.	2,500
5,000	11¼ oz. 79 grs.	10 oz. 3 dr. 20 min.	5,000
10,000	1 lb. 6¾ oz. 49 grs.	20 oz. 6 dr. 40 min.	10,000

TABLE FOR CHANGING OUNCES AND DRAMS INTO THOUSANDTHS OF A POUND.

	DRAMS															
Ounces	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	.000	.004	.008	.012	.016	.020	.023	.027	.031	.035	.039	.043	.047	.051	.055	.059
1	.063	.066	.070	.074	.078	.082	.086	.090	.094	.098	.102	.105	.109	.113	.117	.121
2	.125	.129	.133	.137	.141	.145	.148	.152	.156	.160	.164	.168	.172	.176	.180	.184
3	.188	.191	.195	.199	.203	.207	.211	.215	.219	.223	.227	.230	.234	.238	.242	.246
4	.250	.254	.258	.262	.266	.270	.273	.277	.281	.285	.289	.293	.297	.301	.305	.309
5	.313	.316	.320	.324	.328	.332	.336	.340	.344	.348	.352	.355	.359	.363	.367	.371
6	.375	.379	.383	.387	.391	.395	.398	.402	.406	.410	.414	.418	.422	.426	.430	.434
7	.438	.441	.445	.449	.453	.457	.461	.465	.469	.473	.477	.480	.484	.488	.492	.496
8	.500	.504	.508	.512	.516	.520	.523	.527	.531	.535	.539	.543	.547	.551	.555	.559
9	.563	.566	.570	.574	.578	.582	.586	.590	.594	.598	.602	.605	.609	.613	.617	.621
10	.625	.629	.633	.637	.641	.645	.648	.652	.656	.660	.664	.668	.672	.676	.680	.684
11	.688	.691	.695	.699	.703	.707	.711	.715	.719	.723	.727	.730	.734	.738	.742	.746
12	.750	.754	.758	.762	.766	.770	.773	.777	.781	.785	.789	.793	.797	.801	.805	.809
13	.813	.816	.820	.824	.828	.832	.836	.840	.844	.848	.852	.855	.859	.863	.867	.871
14	.875	.879	.883	.887	.891	.895	.898	.902	.906	.910	.914	.918	.922	.926	.930	.934
15	.938	.941	.945	.949	.953	.957	.961	.965	.969	.973	.977	.980	.984	.988	.992	.996

Left column of figures represents OUNCES. Figures at top of columns represent DRAMS.
Example: To find decimal equivalent of 4 ounces and 10 drams, take the figures opposite 4 and under 10. Result is .289.

TABLE OF AVOIRDUPOIS WEIGHTS.

16 Ounces .....1 Pound
16 Drams .....1 Ounce
256 Drams .....1 Pound

TABLE OF ATOMIC WEIGHTS

Names of Elements	Symbols	Approximate Atomic Weights O=16	International Atomic Weights H=1.008
Aluminum	Al	27	27.1
Antimony	Sb	120	120.2
Argon	A	40	39.88
Arsenic	As	75	74.96
Barium	Ba	137	137.37
Beryllium	Be	9	9.1
Bismuth	Bi	208	208.0
Boron	B	11	11.0
Bromine	Br	80	79.92
Cadmium	Cd	112	112.40
Caesium	Cs	133	132.81
Calcium	Ca	40	40.70
Carbon	C	12	12.005
Cerium	Ce	140	140.25
Chlorine	Cl	35.5	35.46
Chromium	Cr	52	52.0
Cobalt	Co	59	58.97
Columbium	Cb	93.5	93.5
Copper	Cu	63.5	63.57
Dysprosium	Dy	162.5	162.5
Erbium	Er	167.4	167.7
Europium	Eu	152	152.0
Fluorine	F	19	19.0
Gadolinium	Gd	157	157.3
Gallium	Ga	70	69.9
Germanium	Ge	72	72.5
Glucinum	Gl	9	9.1
Gold	Au	197	197.2
Helium	He	4	4.00
Holmium	Ho	163.5	163.5
Hydrogen	H	1	1.008
Indium	In	115	114.8
Iodine	I	127	126.92
Iridium	Ir	193	193.1
Iron	Fe	56	55.84
Krypton	Kr	83	82.92
Lanthanun	La	139	139.0
Lead	Pb	207	207.20
Lithium	Li	7	6.94
Lutecium	Lu	174	175.0
Magnesium	Mg	24	24.32
Mercury	Hg	200	200.6
Molybdenum	Mo	96	96.0
Neodymium	Nd	144	144.3
Neon	Ne	20	20.2
Nickel	Ni	59	58.68
Niobium	Nb	93.5	93.5
Niton (radium emanation)	Nt	222.4	222.4
Nitrogen	N	14	14.01
Osmium	Os	191	190.9
Oxygen	O	16	16.00
Palladium	Pd	106	106.7
Phosphorus	P	31	31.04
Platinum	Pt	195	195.2
Potassium	K	39	39.10
Praseodymium	Pr	140.5	140.9
Radium	Ra	226.5	226.0
Rhodium	Rh	103	102.9
Rubidium	Rb	85	85.45
Ruthenium	Ru	101.5	101.7
Samarium	Sm	150	150.4
Scandium	Sc	44	44.1
Selenium	Se	79	79.2
Silicon	Si	28	28.3
Silver	Ag	108	107.88
Sodium	Na	23	23.00
Strontium	Sr	87.5	87.63
Sulphur	S	32	32.06
Tantalum	Ta	181	181.5
Tellurium	Te	127	127.5
Terbium	Tb	159	159.2
Thallium	Tl	204	204.0
Thorium	Th	232	232.0
Thulium	Tm	168.5	168.5
Tin	Sn	118	118.7
Titanium	Ti	48	48.1
Tungsten	W	184	184.0
Uranium	U	238.5	238.2
Vanadium	V	51	51.0
Xenon	X	130	130.2
Yetterbium (Neoyetterbium)	Yb	172	173.5
Yttrium	Y	89	88.7
Zinc	Zn	65	65.37
Zirconium	Zr	90.5	90.6

TABLE OF THE CHEMICAL ELEMENTS ARRANGED IN THE ELECTROCHEMICAL SERIES

"Metals"

+ 1.	Caesium	24.	Copper
2.	Rubidium	25.	Mercury
3.	Potassium	26.	Silver
4.	Sodium	27.	Palladium
5.	Lithium	28.	Platinum
6.	Barium	29.	Gold
7.	Strontium	30.	Iridium
8.	Calcium	31.	Rhodium
9.	Magnesium	32.	Osmium
10.	Aluminium		
11.	Chromium		*"Non-Metals"*
12.	Manganese	33.	Silicon
13.	Zinc	34.	Carbon
14.	Cadmium	35.	Boron
15.	Iron	36.	Nitrogen
16.	Cobalt	37.	Selenium
17.	Nickel	38.	Phosphorus
18.	Tin	39.	Sulphur
19.	Lead	40.	Iodine
20.	*Hydrogen*	41.	Bromine
21.	Antimony	42.	Chlorine
22.	Bismuth	43.	Oxygen
23.	Arsenic	— 44.	Fluorine

Note of Explanation: The above list shows the order in which the elements displace one another from their salts. For instance, metallic magnesium will displace hydrogen from dilute acids and will also precipitate zinc from a solution of zinc salt. Zinc in turn will precipitate iron from iron salts; iron will precipitate copper from copper salts; copper will precipitate silver from silver salts, etc. In this way, a series has been worked out such that any metal in the list will (generally) displace those which follow it, and be displaced by those preceding it.

Secondary reactions sometimes prevent the precipitation of the metal, but in many cases the displacement is quantitative. The further apart the metals in the series, the greater the amount of heat liberated when reaction occurs and in general the greater their mutual reactivity.

The metals *preceding* hydrogen give hydrogen when treated with acids; those following it usually do not.

With the exception of tin, lead and iron, the metals preceding hydrogen are not found free in nature, but those following it are. The position of oxygen will make one reason for this clear.

TABLE OF BOILING POINT OF VARIOUS COMMERCIAL LIQUIDS

Liquid	Boiling Point Centigrade
Acetaldehyde	21
Acetic Acid (Glacial)	119
Acetic Anhydride	136
Acetone	56
Acetophenone (Hypnone)	202
Amylacetate (Banana Oil)	148
Amyl Alcohol (Iso) (Fusel Oil)	129
Anethol	235
Aniline	183
Anisole	155
Benzene	80.5
Benzyl Alcohol	206
Benzaldehyde (Oil of Bitter Almonds)	179
Benzylacetate	206
Brombenzene	155
Bromoform	151
Bromstyrene	144
Carbon Disulphide	46
Carbon Tetrachloride	76
Chloroform	61
Diacetin	260
Dimethyl Aniline	193
Diphenyl Methane	263
Diphenyl Oxide (Geranium Artificial)	259
Ether	34.6
Ethyl Acetate	77
Ethyl (Grain) Alcohol	78
Ethyl Benzoate	213
Ethyl Bromide	38
Ethyl Chloride	12.5
Eucalyptol (Cincol)	176
Formic Acid	101
Mercury	357
Methyl (Wood) Alcohol	66
Methyl Salicylate (Oil of Wintergreen)	219
Nitrobenzene (Oil of Mirbane)	205
Paraldehyde	124
Phenol (Carbolic Acid)	183
Pyridine	115
Safrol	232
Sulphur Dioxide	—10
Terpineol	216
Toluene	110
Water	100
Xylene	137

TABLE OF PRESSURE OR TENSION OF WATER VAPOR AT DIFFERENT TEMPERATURES

Temperature in Degrees Centigrade	Temperature in Degrees Fahrenheit	Pressure in Millimeters of Mercury
0	32.0	4.6
2	35.6	5.3
4	39.2	6.1
8	46.4	8.0
6	42.8	7.0
10	50.0	9.2
12	53.6	10.5
14	57.2	11.9
16	60.8	13.5
18	64.4	15.4
20	68.0	17.4
22	71.6	19.7
24	75.2	22.2
26	78.8	25.0
28	82.4	28.1
30	86.0	31.6
40	104.0	55.0
50	122.0	92.2
60	140.0	149.2
70	158.0	233.8
80	176.0	355.5
90	194.0	526.0
100	212.0	760.0
110	230.0	1075.4
120	248.0	1491.
130	266.0	2030.
140	284.0	2718.
150	302.0	3581.
160	320.0	4651.
170	338.0	5961.
180	356.0	7546.
190	374.0	9442.
200	392.0	11688.
210	410.0	14324.
220	428.0	17389.
230	446.0	20925.

TABLE OF DENSITIES OF HEAVY LIQUIDS.

(Non-corrosive)

Liquid	Specific Gravity
Carbon disulphide	1.25
Chloroform	1.47
Acetylene tetrachloride	1.58
Carbon tetrachloride	1.60
Bromoform	2.88
Acetylene tetrabromide	2.97
Methylene iodide	3.33
Methylene iodide saturated with iodoform	3.43
Thallium silver nitrate †	4.5-4.9
Metallic gallium *	5.95
Mercury	13.59

† Melts at 75C.

* Melts at 30 C.

FREEZING MIXTURES.

The low temperatures which can be obtained by freezing mixtures depend in the main upon the heat of solution of salts in water. When salts are dissolved, just as when liquids are evaporated, heat is used up through the doing of work. This causes with vapors, gas pressure, with solutions, osmotic or solution pressure. *The quicker the solution of the salt results* (as the quicker the evaporation of a fluid) *the greater is the absorption of heat or lowering of the temperature.* Therefore *such salts are employed for freezing mixtures as completely and quickly dissolve,* and they are accordingly *rapidly mixed in a pulverized condition* with the water (or snow). If ice or snow or salts containing water of crystallization are used, the effect is still greater because then heat is combined through the transition of the water from the solid to the fluid state.

Lowering of Temperature with Water-Salt and Snow-Salt Mixtures.

(The amounts stated are only approximate but sufficiently exact for practical purposes.)

If the salt used is	And the parts by weight below are mixed with 100 parts of water	The temperature (Centigrade) will sink From	To	Or
Crystallized alum	14	10.8°	9.4°	1.4°
Sodium chloride (salt)	36	12.6	10.1	2.5
Potassium sulphate	12	14.7	11.7	3.0
Crystallized sodium phosphate	14	10.8	7.1	3.7
Ammonium sulphate.	75	13.2	6.8	6.4
Crystallized sodium sulphate (Glauber's Salts)	20	12.5	5.7	6.8
Crystallized magnesium sulphate (Epsom Salts)	85	11.1	3.1	8.0
Crystallized sodium carbonate	40	10.7	1.6	9.1
Potassium nitrate (Nitre)	16	13.2	3.0	10.2
Potassium chloride .	30	13.2	0.6	12.6
Ammonium carbonate	30	15.3	3.2	12.7
Crystallized sodium acetate	85	10.7	—4.7	15.4
Ammonium chloride (Sal Ammoniac)	30	13.3	—5.1	18.4
Sodium nitrate (Soda Nitre)	75	13.2	—5.3	18.5
Crystallized sodium thio-sulphate (Hypo)	110	10.7	—8.0	18.7
Potassium iodide	140	10.8	—11.7	22.5
Crystallized calcium chloride	250	10.8	—12.4	23.2
Ammonium nitrate	60	13.6	—13.6	27.2
Ammonium sulphocyanate	133	13.2	—18.0	31.2
Potassium sulphocyanate	150	10.8	—23.7	34.5

If 100 Parts of Snow at —1°C. are Mixed With

Parts of	The Temperature will become Centigrade
10 Potassium sulphate	— 1.9°
20 Crystallized sodium carbonate	— 2.0
13 Potassium nitrate (Nitre)	— 2.85
30 Potassium chloride	—10.9
25 Ammonium chloride (Sal Ammoniac)	—15.4
45 Ammonium nitrate	—16.75
50 Sodium nitrate (Soda Nitre)	—17.75
33 Sodium chloride	—21.3
143 Crystallized calcium chloride ($CaCl_2+2H_2O$)	—50
Solid carbon dioxide + ether	—100

TABLE OF COLORED SOLUTIONS OF VARIOUS ELEMENTS AND THEIR COMPOUNDS

(In water unless otherwise specified)

COLORS

Pink,	*Red,*	*Orange,*	*Yellow,*	*Green,*	*Blue,*	*Indigo,*	*Violet,*	*Brown,*	*Black*
		Chromic acid		Copper chloride (in alcohol)		Chrome alum		Carbon (India Ink)	
Cobalt nitrate		Sodium dichromate Potassium dichromate		Copperas	Copper sulphate	Copper sulphate with ammonia			
		Gold chloride Bromine		Nickel nitrate		Iodine (in carbon disulphide carbon tetra-chloride and chloroform)			
Manganous sulphate Neodymium nitrate Tellurium (in concentrated sulphuric acid)		Iron chloride Platinum chloride Sodium vanadate		Ferrous iodide Sodium manganate Praseodymium nitrate Selenium (in concentrated sulphuric acid) Uranous nitrate Uranic nitrate				Iodine (in alcohol with potassium iodide)	

RULES RELATIVE TO THE CIRCLE, ETC.

To Find Circumference
Multiply diameter by 3.1416. Or divide diameter by 0.3183.

To Find Diameter
Multiply circumference by 0.3183. Or divide circumference by 3.1416.

To Find Radius
Multiply circumference by 0.15915. Or divide circumference by 6.28318.

To Find Side of an Inscribed Square
Multiply diameter by 0.7071. Or multiply circumference by 0.2251.
Or divide circumference by 4.4428

To Find Side of an Equal Square
Multiply diameter by 0.8862. Or divide diameter by 1.1284.
Or multiply circumference by 0.2821. Or divide circumference by 3.545.

SQUARE—
A side multiplied by 1.1442 equals diameter of its circumscribing circle.
A side multiplied by 4.443 equals circumference of its circumscribing circle.
A side multiplied by 1.128 equals diameter of an equal circle.
A side multiplied by 3.547 equals circumference of an equal circle.
Square inches multiplied by 1.273 equal circle inches of an equal circle.

To Find the Area of a Circle
Multiply circumference by one-quarter of the diameter.
Or multiply the square of diameter by 0.7854.
Or multiply the square of circumference by .07958.
Or multiply the square of ½ diameter by 3.1416.

To Find the Surface of a Sphere or Globe
Multiply the diameter by the circumference.
Or multiply the square of diameter by 3.1416.
Or multiply four times the square of radius by 3.1416.

To Find the Weight of Brass and Copper Sheets, Rods and Bars
Ascertain the number of cubic inches in piece and multiply same by weight per cubic inch.
Brass, 0.2972.
Copper, 0.3212.
Or multiply the length by the breadth (in feet) and product by weight in pounds per square foot.

USEFUL RULES.

To find the area of a triangle, multiply the base by one-half the perpendicular height.

To find the area of a trapezoid, add the two parallel sides together and multiply the sum by half the perpendicular distance between them.

To find the area of a regular octagon, multiply the square of the diameter of the inscribed circle by the decimal .828.

To find the area of a regular hexagon, multiply the square of the diameter of the inscribed circle by the decimal .866.

To find the area of a circle, multiply the square of the diameter by the decimal .7854.

To find the area of the section of a flat bar, or the area of a rectangle, multiply the width by the thickness.

To find the number of cubic inches in any bar, multiply the area of its section in inches by its length in inches.

PROPERTIES OF METALS.

Names of Metals	Specific Gravity	Relative Resistance of Wires 100 feet long weighing 1 pound	Relative Resistance of Equal Volume	Atomic Weight	Pounds Deposited in ten hours by ten Amperes
Copper	8.94	1.00	1.06	63.4	.2636
Silver	10.5	1.113	1.00	108.	.8980
Gold	19.26	2.203	1.27	197.	.5460
Aluminum	2.56	.526	1.95	27.	.0569
Zinc	7.13	2.732	3.74	65.2	.2710
Platinum	21.5	13.62	6.02	197.	.4145
Iron	7.84	5.33	6.46	56.	.0776
Nickel	8.82	7.69	8.28	58.8	.1222
Tin	7.30	6.75	8.78	118.	.2453
Lead	11.4	15.55	13.05	207.	.4303
German Silver	8.5	12.16	13.92		
Antimony	6.72	16.69	23.60	122.	.1863
Manganese Steel	7.8	34.82	42.43		
Mercury	13.6	89.76	62.73	200.	.8315
Bismuth	9.8	89.92	87.23	210.	.3492

SPECIFIC GRAVITIES OF METALS.

Names of Metals	Specific gravity	Weights per cubic foot	Specific heat	Melting point Fahrenheit in degrees
Aluminum, cast	2.5	156.06	.214,3	.....
Aluminum, hammered	2.67	166.67	.....	.....
Antimony	6.702	418.37	.050,8	810.
Arsenic	5.763	359.76	.081,4	365.
Barium	4.	249.7	.....	.....
Bismuth	9.822	613.14	.030,8	497.
Cadmium	8.604	537.1	.056,7	500.
Calcium	1.566	97.76	.....	.....
Chromium	7.3	455.7	.....	.....
Cobalt	8.6	536.86	.107	.....
Copper	8.895	555.27	.095,1	1,996.
Copper, rolled	8.878	554.21	.....	.....
Copper, cast	8.788	548.59	.....	.....
Copper, drawn	8.946	558.47	.....	.....
Copper, hammered	8.958	559.25	.....	.....
Copper, pressed	8.931	557.52	.....	.....
Copper, electrolytic	8.914	556.46	.....	.....
Gold	19.258	1,202.18	.032,4	2,016.
Iron, bar	7.483	467.18	.13	2,786.
Iron, wrought	7.79	486.29	.113	3,286.
Steel	7.85	490.03	.116	3,286.
Lead	11.445	714.45	.031,4	612.
Magnesium	2.24	139.83	.249,9	.....
Manganese	6.9	430.73	.114	3,000.
Mercury	13.568	846.98	.031,9	38.
Nickel	7.832	488.91	.109,1	2,800.
Platinum	20.3	1,267.22	.032,4	3,286.
Potassium	.865	54.	.169,6	136.
Silver	10.522	656.84	.057	1,873.
Sodium	.972	60.68	.293,4	194.
Strontium	2.504	156.31	.....	.....
Tin	7.291	455.14	.056,2	442.
Zinc	6.861	428.29	.095,5	773.

TABLE OF SIZES OF TAP DRILLS

Tap Diameter.	Threads per inch.	Drill for V Thread.	Drill for U. S. Standard.	Drill for Whitworth.
1/4	16, 18, 20	5/32 5/32 11/64	3/16	3/16
9/32	16, 18, 20	3/16 13/64 13/64		
5/16	16, 18	7/32 15/64	1/4	15/64
11/32	16, 18	1/4 17/64		
3/8	14, 16, 18	1/4 9/32 9/32	9/32	9/32
13/32	14, 16, 18	19/64 21/64 21/64		
7/16	14, 16	21/64 11/32	11/32	11/32
15/32	14, 16	23/64 3/8		
1/2	12, 13, 14	3/8 25/64 25/64	13/32	3/8
9/16	12, 14	7/16 29/64	7/16	
5/8	10, 11, 12	15/32 1/2 1/2	1/2	1/2
11/16	11, 12	9/16 9/16		
3/4	10, 11, 12	19/32 5/8 5/8	5/8	5/8
13/16	10	21/32		
7/8	9, 10	45/64 23/32	23/32	23/32
15/16	9	49/64		
1	8	1 1/16	27/32	27/32

LUBRICANTS FOR CUTTING TOOLS

Material	Turning	Chucking	Drilling	Reaming	Tapping, Milling
Tool Steel	Dry or Oil	Oil or Soap Water	Oil	Lard oil	Lard oil
Soft Steel	Dry or Soap Water	Soap Water	Oil or Soap Water	Lard oil	Lard oil
Wrought Iron	Dry or Soap Water	Soap Water	Oil or Soap Water	Lard oil	Lard oil
Cast Iron	Dry	Dry	Dry	Dry	Oil
Brass	Dry	Dry	Dry	Dry	Oil
Copper	Dry	Dry	Dry	Mixture	Oil
Babbitt		Dry	Dry	Dry	Oil
Glass	Turpentine or Kerosene				

Mixture is 1/3 Crude Petroleum, 2/3 Lard Oil. Oil is Sperm or Lard Sperm preferable. When two lubricants are mentioned the first is preferable.

CURRENT REQUIRED BY MOTORS.

H. P.	Direct-Current Motors			Alternating-Current Motors								
				Single Phase			Two Phase (4 wire)			Three Phase (3 wire)		
	110 V.	220 V.	500 V.	110 V.	220 V.	500 V.	110 V.	220 V.	500 V.	110 V.	220 V.	500 V.
1	9	4.5	2.0	14	7	3.1	6.4	3.2	1.4	7.4	3.7	1.6
2	17	8.5	3.7	24	12	5.3	11	5.7	2.5	13	6.6	2.9
3	26	13	5.6	34	17	7.5	16	8.1	3.5	19	9.3	4.1
5	40	20	8.8	52	26	11	26	13	5.5	30	15	6.4
7½	60	30	13	74	37	16	38	19	8.1	44	22	9.3
10	76	38	17	94	47	21	44	22	10	50	25	12.
15	112	56	25				66	33	15	76	38	17
20	150	75	33				88	44	19	102	51	22
30	226	113	50				134	67	29	154	77	33
40	302	151	66				178	89	39	204	107	45
50	368	184	81				204	102	45	236	118	52
75	552	276	122				308	154	68	356	178	77
100	736	368	162				408	204	90	472	236	104
150	1,110	555	244				616	308	135	710	355	156
200	1,474	737	324				818	409	180	940	470	208

This table gives the current taken, at full load, by various sizes of electric motors for direct and alternating current at the ordinary pressures of 110, 220 and 500 volts. The current taken by direct current motors depends upon the efficiency, and with alternating-current motors it also depends upon the power factor. These qualities vary somewhat in motors of different make, so the above values must be considered as fair averages. They are useful in making wiring calculations, fixing size of fuses, etc. The current given for two-phase motors is the full-load current taken in each phase; the current for the three-phase motors is the current in each of the three line wires.

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