the silver nitrate ($AgNO_3$) and ammonium bromide (NH_4Br) react on each other and form ammonium nitrate (NH_4NO_3) and silver bromide ($AgBr$), which is a double decomposition, thus:

$AgNO_3$	+	NH_4Br	=	NH_4NO_3	+	$AgBr$
Silver nitrate		Ammonium bromide		Ammonium nitrate		Silver bromide

You will easily know when this reaction has taken place, for the silver bromide ($AgBr$) will form in little drops, or

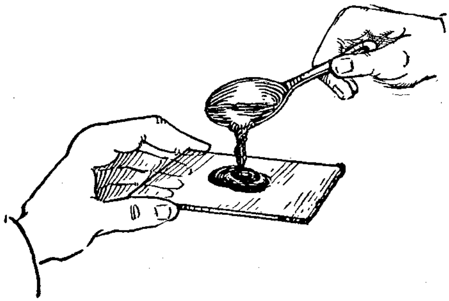

FIG. 151.—Coating the Plate with Silver Emulsion.

granules, all through the gelatine solution, or emulsion,[1] as it is now called. Now let the latter get cool, becoming about as thick as jelly, and cut it up into bits about 1/8 inch square. The next thing to do is to soak the emulsion in water (H_2O) over night in order to wash all the ammonium nitrate (NH_4NO_3) out of it, leaving only the silver bromide ($AgBr$).

[1] Strictly speaking, an emulsion is a liquid in which the solid particles of some other substance are held in suspension, that is, evenly distributed through it.

This done, melt the emulsion and then hold a perfectly clean glass plate in one hand, as shown in Fig. 151, pour a tablespoonful of it in the center, quickly tilt the plate so that the emulsion will flow all over it, then lay it on a perfectly level surface and let it dry over-night. All these operations must be performed in a dark room illuminated only by a very feeble red light, and while there should be a good current of air circulating in the room, it must be absolutely free from dust. Films are made by coating long strips of celluloid with the same kind of silver bromide ($AgBr$) emulsion as that described above, but it takes machinery of a special kind to do this evenly.

How a Picture is Made on a Dry Plate or a Film. When you make a picture with your camera, the image formed by the lens falls on the dry plate, or film, and the light instantly acts on the silver bromide ($AgBr$) on the gelatine surface in proportion to its intensity, and decomposes the silver bromide ($AgBr$) into particles of pure silver (Ag) and bromine (Br). The result is that the silver (Ag) remains on the plate or film as a brown powder and the latter is set free, thus:

$AgBr$	+	$Light$	=	Ag	+	Br
Silver bromide		Light		Silver		Bromine

This reaction, which may take place in the 1/1000 part of a second, or less, cannot be seen in the sensitized surface, and in order to bring out the picture, the plate must be *developed*, to dissolve and wash away those parts of the silver bromide ($AgBr$) which the light has not acted on.

How to Develop a Dry Plate or a Film. To develop a plate, or a film, you must soak it in a solution called a *de-*

veloper, and this you can make by dissolving 30 grains of hydroquinone ($C_6H_6O_2$), 10 grains of metol, 350 grains of sodium sulphite (Na_2SO_3), 350 grains sodium carbonate (Na_2CO_3), and 5 grains of potassium bromide (KBr), and 10 ounces of distilled water (H_2O). In making up this developer, use only the very best chemicals, and see to it that the sodium sulphite (Na_2SO_3) and sodium carbonate (Na_2CO_3) are good clear crystals.

Now when you soak the exposed plate, or film, in this developer, the gelatine is softened by it and the bromine (Br) that has been separated from the silver bromide ($AgBr$) by the action of light is absorbed by the developer, and this leaves the pure silver (Ag) behind. As the development goes on, you can see the picture slowly "come up," that is, come into view — a most fascinating process — as the contrast grows greater between the parts which the light has affected and those which it has not affected. The parts, however, that were *white* of the object which was photographed will show in the developed plate as *black*, because the silver (Ag) that has remained behind is black, and, oppositely, the parts of the object that were *black* will show as *white*, for here the silver bromide ($AgBr$) was not affected. In other words, the black and white parts on the plate, or film, are just the reverse of those of the object that was photographed, hence, the plate is now called a *negative*.

How to Fix the Picture. If the developed plate, or film, should again be exposed to the light it would decompose the remaining silver bromide ($AgBr$), and all of it would be decomposed into silver (Ag) and bromine (Br). To keep this action from taking place when the picture has reached the proper stage of development, it must be *fixed*, as it is called, and, naturally, thus must also be done in a dark room.

To fix the plate, or film, you must soak it in a *fixing bath*, which is simply a solution that you make by dissolving ½ pound of sodium thiosulphate, ($Na_2S_2O_3$), often incorrectly called *hyposulphite*, or *hypo*, for short, in ½ pint of boiling water (H_2O), and then adding another ½ pint of cold water (H_2O) to it. Keep this in a corked bottle until you want to use it. When you are ready to *fix* the picture, put the plate, or film, in a glass tray three-fourths full of the hypo fixing bath and let it stay there until all the silver bromide ($AgBr$), not acted on by the light, is dissolved out; you will know when this action has taken place, for the opaque whiteness of the plate disappears, and you will be able to see the transparent picture by holding the plate, or film, to the light.

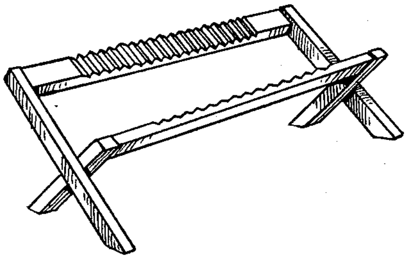

FIG. 152.—A Negative-Rack.

Let the negative remain in the fixing bath for ½ hour or more so that every particle of the silver bromide ($AgBr$) may be dissolved, and then wash it for an hour under running water (H_2O), or in many changes of it, in order to remove all the hypo with which the gelatine coating is saturated and which if not removed will stain the negative. After washing the negative, set it in a rack, see Fig. 152, and let it dry slowly in a cool place where there is a good circulation of air.

How to Make a Print from a Negative. Now while the white and black parts of the picture on the negative are just the reverse of what they were of the object you photographed, you can make a *positive*, or as many as you want, on paper or on glass. When positive copies are made on paper they are called *prints*, and when they are made on glass they are called *transparencies*, if they are to be viewed by the light shining through them, or *lantern slides*, if they are to be projected on a screen.

Kinds of Printing Papers — Silver Papers. There are different kinds of papers used for making photographic prints, but all are coated with either a nitrate, a chloride, or a bromide silver compound. Those coated with silver nitrate ($AgNO_3$) are slow printing papers and must be exposed to the sunlight, hence, they are called *printing-out* papers. There are two kinds of printing-out papers, the first of which is known as *silver paper*. This is coated with albumen, which is *white-of-egg*, and therefore an organic substance, and then with a solution of silver nitrate ($AgNO_3$); the second is called *solid paper*, and this is coated with gelatine, also an organic substance, and then with a silver chloride ($AgCl$).

How to Make a Print. To make a print, you need a *printing-frame*, as shown in Fig. 153. Take the back out of it, lay the negative in the frame with the film side up, that is, toward the back, and lay the sheet of sensitized paper on it, with its film side down, that is, next to the negative. Now put the back in the frame and clip the ends of the springs, which are pivoted to the back, under the catches that are fixed to the frame.

If you are making a silver or solid print, set the frame out of doors so that the sunlight will fall directly on the negative. From time to time take the frame into a more subdued light and unclip one of the springs. Then you can lift up half of the back (it is hinged together) and look at the print to see how it is coming on. The print when ready to be taken out of the frame will be a positive, for the light that goes through the clear parts of the negative will turn the paper brown or black, and, conversely, where the negative is black, the light cannot get through, and so the paper remains white.

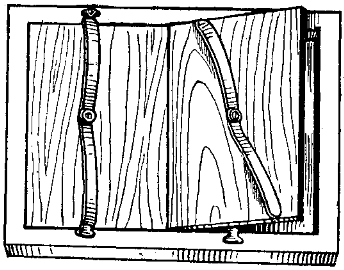

FIG. 153.—A Printing-Frame.

How to Tone the Print. The appearance of a silver print is never very pleasing as it comes from the frame, and to give it a soft rich color you must *tone* it. This you do by putting it in a tray that contains a *toning solution*, as it is called; it consists of two solutions which you make up as follows: put 7 drams of distilled water (H_2O) in a small bottle and dissolve 7 grains of *auric chloride* ($AuCl_3$), or *gold chloride*, as it is commonly called, in it and label it, *Solution No. 1.* Then put 5 ounces of water (H_2O) in another bottle and dissolve 220 grains of ammonium sulphocyanide ($(NH_4)_2HSCN$) in it and label it, *Solution No. 2.* When you are ready to tone the print, put 2½ ounces of water (H_2O) in a tray and then add 1 dram of Solution No. 1; stir it with a glass rod slowly, and then put in 1 dram of the Solution No. 2; let it stand for 10 minutes, and it will then be ready for use. Now put the print in this solution and keep turning it over constantly until a rich deep-brown color is reached; next, wash it in two or three changes of water (H_2O), and then fix it for 15 minutes in a fixing bath made of ¾ ounce of sodium thiosulphate ($Na_2S_2O_3$) dissolved in 5 ounces of water (H_2O), and in which you have stirred a drop or two of liquid ammonia (NH_4OH).

After fixing the print for ½ hour, wash it in running water (H_2O) for an hour or so, or in numerous changes of water (H_2O). Finally, dry the print, and you will have a finished photograph.

How to Make a Velox Print. About 20 years ago a paper was introduced under the trade name of *velox*. This new kind of paper, which is coated with a silver bromide ($AgBr$) emulsion like plates and films, gives a beautiful black-and-white print. The great advantage of using it lies in the fact that it can be printed by gas-light — hence in England it is called *gas-light paper* — and while it must be developed, like a plate or a film, this does not take anywhere nearly the length of time that printing and toning a silver print does. Because of these advantages it soon found favor with both amateur and professional photographers, and it was not many years before the silver print was entirely supplanted by it except for commercial art work.

How to Make and Use Blue Paper. This paper is by all odds the cheapest and simplest kind to make and use, since a salt of iron is employed for sensitizing the surface of it, and it only needs to be washed thoroughly to bring out the picture and to fix it. For these reasons it is largely used by engineers and architects for making prints of drawings and plans, but you will find it gives you pretty prints of many objects and especially of marine views. While the paper is easy to make, still, owing to the poisonous nature of the chemicals employed, I would advise you to buy it ready-made.

Blue paper is made by dissolving ¼ ounce of green iron ammonio-citrate in 1 ounce of water (H_2O), and the same amount of potassium ferrocyanide ($K_3Fe(CN)_6$) in a like amount of water (H_2O). The two solutions are now mixed together and the surface of some unruled sheets of writing paper, or other well-sized paper, is coated over with it by means of a brush. It is then dried in a dark room, after which it is ready to be printed in the sunlight like silver paper. The only other operation is to wash it for ½ hour in running water (H_2O), or in many changes of it.

CHAPTER XIII.

THE WHITE MAGIC OF CHEMISTRY

THERE are a great many experiments in chemistry that have been used by magicians the world over during the last half-century, and these are as pleasing to-day as when they were just invented. In recent years, however, the knowledge of chemistry and of chemical processes has advanced to such an extent that the average spectator is not so easily deceived as he once was, but, curiously enough, even though he has an idea of how the tricks are done, in the last analysis, the effects are still quite as wonderful, for chemistry *is* magic. In this chapter I shall tell you how to perform enough startling experiments for a show that will last for half an hour or more.

Pouring Wine and Water from the Same Pitcher.— The Effect. Like a miracle of old, you pour from the same pitcher wine or water (H_2O) as the audience calls for it. On the table you have a clear glass pitcher full of water (H_2O) and half a dozen empty tumblers standing in front of it, as shown in Fig. 154. After a few remarks on making your own wine you ask the audience which it prefers, wine or water (H_2O), and you proceed to fill one of the tumblers with whichever beverage is called for.

When you have filled half of the tumblers with wine and half with water (H_2O), you pour them back into the pitcher and all will instantly change into wine, which you prove by filling up the tumblers. This done, you pour the wine back into the pitcher, and it is changed instantly into water (H_2O), as at the beginning, and you demonstrate the fact by filling up the glasses with it.

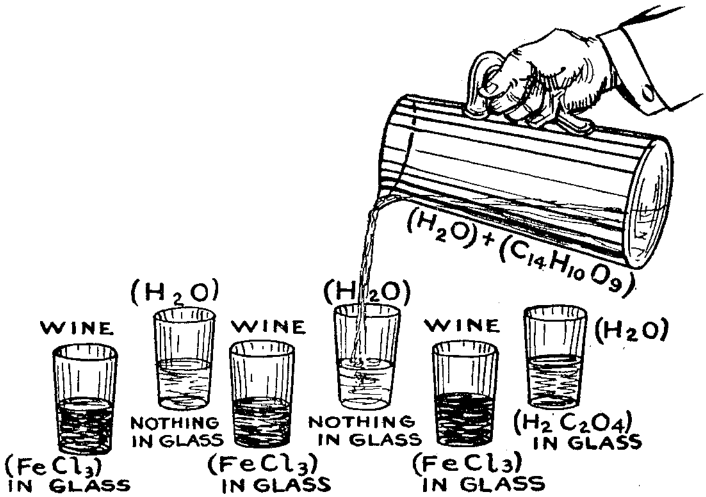

FIG. 154.—How Wine and Water are Poured from the Same Pitcher.

The Cause. It takes not the slightest skill to perform the trick. All you have to do is to dissolve 1 tablespoonful of tannic acid ($C_{14}H_{10}O_9$), which is a brownish powder made of nut-galls, in a pitcher of clean warm water (H_2O); now put ¼ teaspoonful of oxalic acid ($H_2C_2O_4$), which comes in needle-shaped white crystals, into one of the tumblers and pour on just enough hot water (H_2O) to dissolve them; finally, put 3 or 4 drops of *tincture of iron*,[1] which is ferric

[1] You can get all these chemicals at a drug store.