same time watch the spark gap to see if the spark was produced or not. After having put all the apparatus in a working condition try a plate.

Nothing has been said heretofore regarding the kind or size of plates or the kind of camera to be used. For the camera one with a lens of large aperture is preferable to one of small aperture. However, the lens of almost any camera may be used if the pencil of rays coming from the condensing lens is focused exactly upon the center of the camera lens. For the plates, fast ones are best to use, and the faster the plate the better the picture. The writer used Lumiere Sigma plates with good results. The plates should be large enough to show about four or five inches of the path of the bullet. By consulting the illustrations it will be seen that the contact wires were placed so that they just showed on one side of the plate, thereby leaving the rest of the plate to catch the projectile.

After exposing the plate develop it immediately or in a short time. Use any reliable developer and use a solution of such strength that developing will not have to be carried on for more than five minutes. Fix the plate in a strong acid hypo solution and let it fix about twice as long as it takes it to clear. Wash the plate thoroughly and dry it in such a position that the dust will not settle upon it. It will be found convenient to make the dark room in which the experiment is carried on, serve as the photographic dark room. This saves a great deal of time as well as trouble. If the foregoing instructions are followed, the writer feels confident that there will be no great trouble in obtaining good negatives of projectiles in flight. A great deal depends upon the experimenter, and he must depend upon himself to correct some possible defects which might arise from his own methods of wiring and arranging the apparatus. There is still a large amount of knowledge to be gained by this fascinating work, and it is within reach of a great many who do not realize the possibility of their carrying out this experiment.

In one of the illustrations at the left is seen the muzzle of the gun and the projectile which has just emerged from it. Around the back part of the projectile are seen the jets of expanding gases. The volume of smoke and gas which precedes the bullet from the barrel is shown very plainly. The white streak is the spark between the contact strips. Many interesting and instructive pictures of this sort are in reach of those who follow out the foregoing explanations and instructions.

The writer wishes to say that he is greatly indebted to Prof. J. R. Towne, of the Department of Physics at the East High School of Minneapolis, Minn., as it was through his kind permission that the use of the laboratories was obtained for carrying out this interesting experiment.

Neat Method of Testing Shutter-speeds

By H. H. F. Clarke

IT is always better to test the speeds of instantaneous shutters to see if they give the correct exposures after one has had them for some time, more especially when they are bought second-hand. In some cases the wood either swells or contracts. This is due to various causes, chiefly sun and damp, and the shutter, though apparently running freely, runs slower due to friction.

Take a piece of fairly thin board *AA* and drill a small hole through it. On one side of this hole attach, by means of a very weak spring, a sheet of mica *K* so that it just touches the board. A piece out of a discarded recorder does very well. To the center of this fasten another light spring *I*, which has a very fine brush composed of a few camel hairs tied on the end. Do not attach the springs (which can be made out of watch main springs, softened, filed down, and then retempered) with sealing wax, as it is too brittle. Some of the cements used for mending china do very well, or even strong spirit gum does at a pinch.

Now take a worn-out gramophone disk and paste a white piece of paper of the same size over it. The paper should be cut to the required size, a good layer of paste put over it and laid aside for ten minutes, then another layer of paste applied and the whole firmly pressed against the disk. The paper will then dry with a perfectly smooth surface. The object of the first layer of paste is to stretch the paper, which, when placed on the disk and allowed to dry, shrinks, thus forming a perfectly level surface.

Now fit the prepared disk on a gramophone and clamp the apparatus, described above, so that the little brush, which has been previously soaked in some coloring matter (red ink does very well) very nearly touches the paper, but as near its edge as possible. Set the gramophone running at a known rate. Now place the shutter to be tested over the hole in the wood and project a gentle stream of air, either with the mouth or foot bellows, through the tube *C* against the shutter *DD BB*. Release the shutter, and the stream of air passes through, reaches and depresses *K* a fraction of an inch and causes the brush *I* to mark a line on the gramophone disk *G*.

Now, say you set the gramophone going at 120 revolutions a minute, divide this by 60. Then the disk makes two complete revolutions in a second.

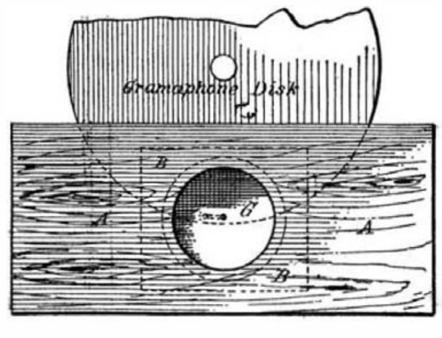


Fig. 1

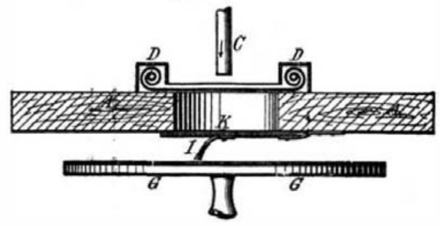


Fig. 2

Testing a shutter with a gramophone.

Measure the distance from the mark made by the dye-soaked brush to the center of the disk; call it x. Multiply this length by 6.28. Then $6.28 \times x$ is the distance traveled by a point on the disk, at the same distance from the center as the brush, in one complete revolution. Now there are two complete revolutions in one second, so the distance traveled in one second is $6.28 \times x \times 2$. Now measure the line marked by this brush; call this y. Then the speed of the shutter will be $\frac{y}{6.28 \times x \times 2}$ seconds, or expressed in another way $\frac{6.28 \times x \times 2}{y}$ part of a second.

Most gramophones and phonographs have an accurately governed motor, and when the regulator is put at a certain mark the disk travels at so many revolutions a minute. If this is not the case with yours, you can easily determine its speed with a little ingenuity. Either notice how many revolutions the disk makes for one revolution of one of the slower running gear wheels, and from this calculate the number of revolutions in a second, or else fix a small piece of white paper to a disk and count the number of times it passes a certain mark in a definite number of seconds (a convenient number is ten).

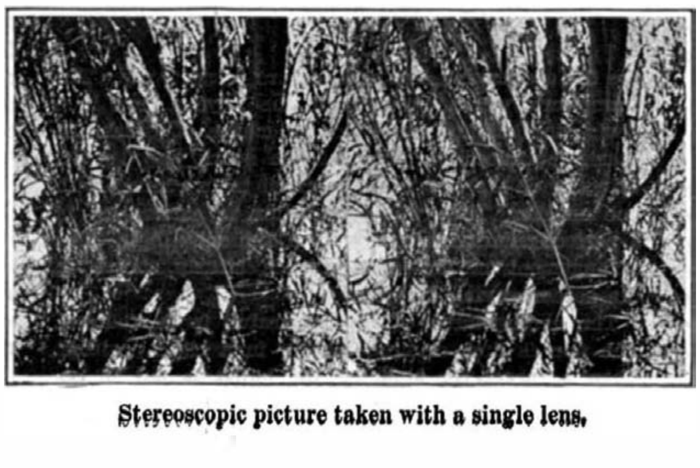
Either a gramophone or phonograph may be employed. Perhaps the gramophone is a little better, as the line you get is longer and so your work is a little more accurate if anything. It is necessary to notice that the apparatus is fitted up so that the spring brush is not torn off when the mica plate is depressed by the current of air. If fixed up in one way, as can easily be seen, the spring will be bent back and probably torn off the plate.

Improvised Stereoscopic Camera

By John E. Mellish

THE writer possesses a 5×7 camera with an exceptionally fine lens and with a double extension bed. Desiring to take some stereoscopic views with this camera the following scheme was hit upon: To start with, a stand was made with three legs and a flat top fifteen inches square. A lath was secured to the top at one edge, forming a guide rail against which the camera was set. With this simple contrivance stereoscopic views were easily obtained. The camera was set on the stand against the lath, but a little to one side of the center, and the focusing was done carefully on the ground glass. The lens was stopped down in order to bring out details clearly. After exposing one plate the camera was moved sidewise and a second view was taken. For objects near by the camera was moved laterally about three inches, but for distant objects and scenes, the lateral displacement was as much as a foot. In this way two views were obtained that were found to show up with wonderful distinctness in a stereoscope. The accompanying illustration shows two views taken in this way. It was essential in this case to pick out an hour when no wind was stirring so that there would be no blurring of the leaves.

Stand for taking stereoscopic views.



Stereoscopic picture taken with a single lens.

Silvering Reflectors

SEVERAL letters have been received by the Editor of Home Laboratory, complaining that the directions given in the article on the Construction of a Four and One-half Inch Reflector must be wrong; for even though they were carefully carried out no silver would adhere to the glass. The failures appear to be due to the following causes: First. Nitric acid containing a trace of chlorine would give a faint precipitate which would prove fatal in getting a perfect deposit of silver. Second. The glass may not have been made sufficiently clean. Third. Common water if used to mix the chemicals for the solution would also cause precipitate of silver chloride, sulphate, and an organic compound of silver, thus causing failure. The water used for the mixing and final washing before silvering *must* be distilled water.

The following solution for silvering can be entirely relied upon, but distilled water *must* be used in making the solution. The process is known as "Martin's Silver Process:"

Solution A. Nitrate of silver, 175 grains; distilled water, 10 ounces. Solution B. Nitrate of ammonium, 262 grains; distilled water, 10 ounces. Solution C. C. P. caustic potash, 1 ounce (av.); distilled water, 10 ounces. Solution D. Pure white sugar candy, ½ ounce (av.); distilled water, 5 ounces.

Dissolve this by heating the flask and add fifty grains of tartaric acid, boil this mixture for ten minutes in the flask and when cold add one ounce of pure photographic alcohol, made up to ten ounces by adding distilled water.

For use mix equal parts of A and B in one graduate, and equal parts of C and D in a separate graduate. Finally mix these two together and suspend the glass to be silvered face down in this mixture; allow it to stand until the deposit of silver is complete.

The glass can be cleaned by very carefully washing it in a warm solution of common washing soda, with a tuft of absorbent cotton pressed in the end of a stout rubber tube and used as a mop. Wash well under the faucet, then rinse well in a mixture of nitric acid one part to forty of water, and rinse well under the faucet. Finally wash in distilled water, drain, and then immerse in the silvering liquid.

Tungsten Wire

DUCTILE metallic tungsten is now produced in the electric furnace. Tungsten particles have been hitherto welded into a continuous filament by passing an electric current through a binding material containing the metallic particles and driven off by the high heat. By this new method the metallic tungsten can be drawn into fine wire much stronger and more rugged than the sintered filament.