A SIMPLE METHOD OF LAYING OUT A SUN DIAL.

BY F. WILLARD BROWNE.

The sun is a very poor timekeeper. At this time of the year it is about a quarter of an hour fast, while in February it will be nearly fifteen minutes slow. For this reason we do not take time from the real sun, but from an imaginary sun which comes to meridian every twenty-four hours exactly on the second. There are only four days in the year when the real sun is on time, viz., April 15th, June 15th, September 1st, and December 25th. A sun dial records the real sun's time and not the mean sun's time, and consequently is a very poor timepiece for actual service in these days. However, it makes a very attractive ornament, and readers of Handy Man's Workshop may find it interesting to make a simple dial. It is popularly supposed that the laying out of the sun dial face is a difficult matter, but this can be done without the use of mathematics if the difference between the real solar time, the mean solar time, and standard time is clearly understood. Noon, strictly speaking, is the moment when the sun comes to meridian; that is, when it is due south of the observer. As we have just stated, if we depended upon the real sun to mark the noon hour, some of our days would be shorter than others. Our watches would have to run anywhere up to thirty seconds a day fast and slow at different times of the year, in order to keep pace with the real sun. The imaginary sun which keeps perfect time is not much better for general purposes because noon would be different to different observers. A man in New York would have different time from a man in Brooklyn. A commuter from the Oranges would have to set his watch ahead about a minute when going to business and back a minute when returning home. To avoid all this complication we take our time from the mean noon at certain fixed meridians just 15 degrees apart. The eastern section of the country gets its time from noon at the seventy-fifth meridian west of Greenwich; central time is taken from noon at the ninetieth meridian; mountain time, from the hundred-and-fifth meridian; and Pacific time from the hundred-and-twentieth meridian west of Greenwich. Bearing these facts in mind, we can proceed to lay out our dial without the use of mathematics on the four days above referred to when the real sun and the imaginary sun come to meridian at the same time.

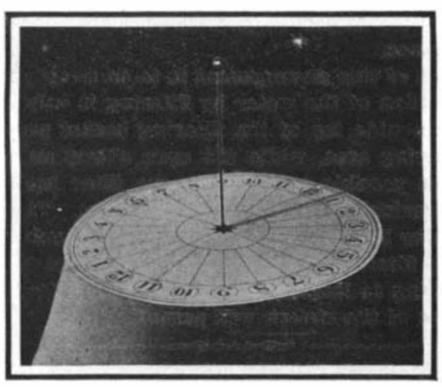


Fig. 1.—A SUN DIAL FOR USE AT THE NORTH POLE.

First of all, it is absolutely necessary that the line casting the shadow on the dial face shall be absolutely parallel with the axis of the earth. This being the case, it makes no difference what the position or form of the surface receiving the shadow may be so long as it is rigid. Our problem resolves itself therefore into the question of how we shall provide for the placing of this shadow-casting line.

It is perfectly apparent that at the North Pole this line would occupy merely an upright position, and a dial for such a situation would be similar to Fig. 1. At the southern extremity of the earth's axis a similar instrument would be required, except that the hour marks would have to number round in the opposite direction.

At the equator an apparatus similar to Fig. 2 has been devised. If the shadow-casting line is to be parallel to the earth's axis, it is evident that at this point it must be perfectly horizontal and pointing north and south. Just here it may be of interest to call attention to the fact that at the equator the sun always rises and sets at six o'clock. The most convenient surface to receive the shadow from a line placed as above described would be the interior of a half cylinder; and if this were equally distant at all points from said line, the hour marks would be twelve equal divisions of its surface. This same form of sun-dial could be used at any latitude, provided it has an arrangement for canting it up (Fig. 3) so as to maintain the position of the axis line parallel with the earth's axis.

In latitudes midway between the equator and the poles a horizontal form of sun-dial is most commonly used, and we will construct ours according to that model.

Fig. 4 affords a general idea of the method of construction.

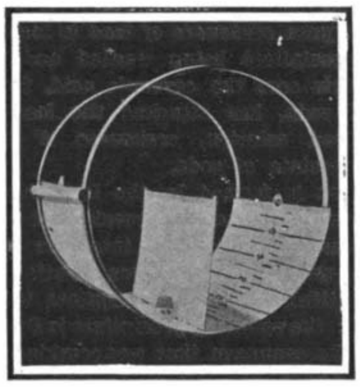


Fig. 2.—A SUN DIAL SUITABLE FOR USE AT THE EQUATOR.

The material should be well-seasoned pine for the baseboard, which may consist of two pieces of ¾-inch stock measuring 10½ by 6 inches each, with two 12-inch cleats to correspond. In the preparation of the gnomon or shadow-casting piece *A B C*, the essential feature is that the angle at *B* shall invariably correspond in degree with the latitude of the locality where the dial is to be placed. For instance, since Boston is 42 deg. 21 min. north latitude, angle *B*, if the dial is to be used in Boston, must be a shade over 42 1/3 degrees; at New York the angle *B* should be 40 3/4 degrees.

The base line of the gnomon should be at least long enough to extend two-thirds of the way across the board. If our dial is to be for indoor use only, the shadow piece may be constructed of heavy bookbinder's pasteboard, but for outdoor exposure it had better be made of brass or heavy galvanized sheet iron. Make a paper pattern, and get your tinsmith to cut it out for you. The out-of-door sun dial should receive at least three good coats of the best white lead paint as a protection from the weather.

Having reached this point, and having assembled the various parts, fastening them securely in place with screws or good wire nails, we are now ready to make our markings upon the dial surface for the twelve or fourteen hours of daylight during which our sunshine clock will be of service. These may be made temporarily with lead pencil, and afterward lined in with waterproof ink or good black paint.

It is very essential while placing these lines, of course, that the dial shall remain in an absolutely fixed position, and that the gnomon shall point exactly north and south, as it ought always to do if our time is to be at all accurate. Now, without a surveyor's compass how shall we accomplish this? Mean solar noon in Boston is at sixteen minutes of twelve o'clock. By that we mean that at 11:44 the imaginary sun is directly in the south; and if at noon on Christmas day or any other of the four days above mentioned when the imaginary and real suns coincide, we place our dial so that the gnomon, with angle *B* toward the south, casts at either side no shadow whatever, the shadow that extends from the edge of the gnomon marks the hour of XII. At 12:44 a line drawn along the shadow will be the I o'clock mark of the real solar time. With a reliable timepiece in hand we may thus proceed to make the necessary markings as the hours go by, being careful of course to see that the position of the instrument has not been altered. The morning hours will bear the same relative distances from XII on the opposite side of the dial.

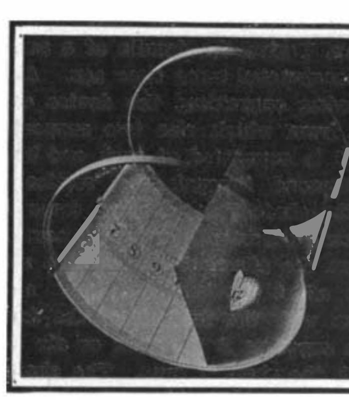


Fig. 3.—A CONVEX DIAL TILTED TO THE ANGLE OF ITS LATITUDE.

To find the difference between mean solar time and the standard time for any locality apply the following rule: Ascertain the difference in longitude between the given place and the meridian of the standard time of that locality, as indicated by the following table:

Colonial time is mean solar time of	60th meridian
Eastern time is mean solar time of	75th meridian
Central time is mean solar time of	90th meridian
Mountain time is mean solar time of	105th meridian
Pacific time is mean solar time of	120th meridian

Multiply the number of degrees of difference in longitude by four, and the result will be the difference of time in minutes.

If the standard meridian is the larger of the two, mean solar noon will occur just as many minutes before 12 o'clock standard time. If it be smaller, the time will be so many minutes later.

To illustrate:

The meridian of eastern time is	75	deg.
Longitude of Boston is	71+	deg.
	4	deg.
Multiply by	4	
	16	minutes.

The meridian of eastern time being the *larger*, therefore mean solar noon will occur at 16 minutes *before* 12 o'clock, and the sun dial must be placed so that the gnomon casts no shadow at that time.

Should it be thought desirable to construct a vertical sun dial to be attached to the southern wall of a house, for instance, the same principles apply as we have already laid down, only be sure to bear in mind that the essential angle of the triangular gnomon is always the one farthest to the south, and not the one resting against the baseboard. It is more than probable that the wall to which the dial is to be fastened does not face exactly south, so that it will be necessary to bend the gnomon slightly to the east or west, in order to get the proper direction for its upper edge.

Having had good success in the construction of one or more sun dials made according to the foregoing suggestions, possibly it may be thought desirable to construct something of a more permanent nature, and the following directions in regard to the use of concrete for that purpose may be of service.

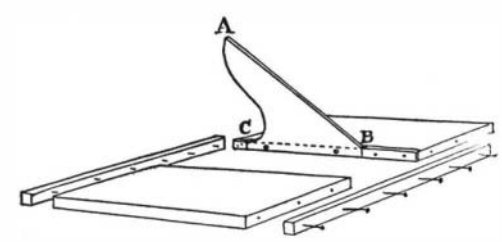


Fig. 4.—CONSTRUCTION OF A HORIZONTAL DIAL.

In making a mold for the construction of the plane portion of the dial, one of two methods may be followed. Make a shallow box the exact size and shape of this part of the dial. Before the bottom board is fastened on, draft upon its interior surface a reversed tracing of the markings of a previously constructed dial, giving of course also the hour-mark figures. These may now be gone over with a V-shaped chisel if raised markings are desired, or they may be built up with modeler's wax if figures indented in the stone surface are thought to be more desirable. A thin but tapering piece of board should be fastened at the point where the gnomon is to be inserted later on. The entire mold should now be thoroughly gone over with tallow, to prevent the concrete mixture from sticking at any point.

A good concrete for our purpose may be made of two parts sand and one of Portland cement. These should be thoroughly mixed before water is added. About 20 per cent of water is supposed to be about the right proportion to use, but a better rule to follow is to continue to add water until the mixture has such a consistency that tapping upon it with a flat trowel will bring water to the surface. The concrete should be allowed to set for five or six hours before the mold-boards are removed, and, by the way, these should have been fastened together with screws. After this the stone should be kept moistened every hour or two for two or three days to obtain the best results. Another method of making this part of the dial, though the result might not be quite satisfactory, would be to fill a shallow box with concrete, working the markings into the surface before it has begun to set very much.

The gnomon may be made of iron by your blacksmith neighbor, in which case it ought to undergo some treatment to prevent its rusting; or it may be cast of brass from a wooden model. Having this firmly cemented in the groove provided for it, we have now a dial ready for whatever surroundings may seem desirable. Concrete stone may be rendered impervious to the action of water or frost by the following treatment: First, wash it thoroughly with a hot solution of Castile soap, and after rubbing in and drying, apply a solution of alum.

Since the color of the concrete may not be wholly satisfactory for receiving the shadow of the sun, the upper surface of our stone may be kept painted with lead paint or with an insoluble whitewash.

EXPERIMENTAL COLOR MAKING WITH SIMPLE CHEMICAL SOLUTIONS.

BY A. J. JARMAN.

Color manufacturing to-day is carried out upon a very large scale, and so cheaply that it has often been considered quite impracticable for the amateur to prepare his own colors; but one should bear in mind that the colors so produced are of absolute purity, containing no adulteration whatever. Furthermore, there is not only an elementary knowledge of chemistry obtained, but a useful and valuable product, at the cost of a very small outlay.

The following colors can be easily made, without the use of special chemical vessels, the one essential point being that all the water used should be filtered, so as to free it from organic matter and mechanical impurities, in the form of iron rust, and sometimes small fragments of carbonate of lead, obtained from the lead supply piping.

The following solutions must be made in clean glass bottles, half a dozen strips of glass half an inch wide and ten inches long, and half a dozen or more of common glass tumblers, and a few sheets of white blotting paper.

In the clean bottles make up the following chemical solutions:

1. Iodide of potassium, 120 grains dissolved in 10 ounces of water; a label being placed thereon with the name of the chemical.
2. Bichloride of mercury, 120 grains dissolved in 10 ounces of hot water, and allowed to become cold.
3. Two drachms of nitrate or acetate of lead dissolved in 10 ounces of hot water.
4. Half an ounce of protosulphate of iron dissolved in 10 ounces of water.
5. Half an ounce of ferricyanide of potassium (*red* prussiate of potash), also dissolved in 10 ounces of water.
6. Half an ounce of bicarbonate of soda dissolved in 10 ounces of water.
7. Two drachms of nitrate of silver dissolved in 10 ounces of distilled water.
8. Half an ounce of bichromate of potash dissolved in 10 ounces of water.

Now having all these chemical solutions made, proceed as follows: Pour into one of the tumblers two or three ounces of the bichloride of mercury solution, then add carefully half an ounce of the iodide of potassium solution; stir well with one of the glass strips, when instantly a beautiful deposit of scarlet vermilion will be formed.

Be careful not to add too much iodide solution, because this scarlet vermilion is soluble in a solution of iodide of potassium, which may become partially or wholly re-dissolved. If this is the case, continue to add more of the bichloride of mercury solution, when the precipitate will return. Always have the mercury solution in *excess;* this will do no harm. The precipitate, or scarlet vermilion, is known chemically as *iodide of mercury.*

The iodine, which was chemically bound up with potassium, was freed when the iodide solution was mixed with the bichloride of mercury solution; there being a greater affinity between the iodine and mercury than between iodine and potassium; hence the change. So iodide of potassium and bichloride of mercury, when brought together in solution, form *iodide of mercury* and chloride of potassium.

To purify the color so produced, all that is necessary is to allow the precipitate to subside, pour off the clear portion (this contains the chloride of potassium which is held in solution), pour upon the precipitate some clean water. Allow it to subside. About four such washings will remove the impurity. Then fold a piece of white blotting paper, about ten inches square, so as to form a quarter of the sheet. Open the fold, pour into it the wet precipitate, wash out the tumbler, pour the washings into the blotting filter, and place the blotting filter into another tumbler, or into the same one, if more convenient. When the precipitate has become well drained, it may be allowed to dry, or be used in a moist condition by adding a few drops of gum arabic mucilage, being well incorporated with a bone or hard rubber paper knife upon a piece of ground glass, or when dry, ground with a pestle in a small mortar, and used as desired. The above description of filtering will apply to *all* the following colors.

Pale lemon yellow is made by pouring two or three ounces of the lead solution into a clean tumbler, and adding half an ounce of the iodide of potassium solution. Stir the mixture well; the pale yellow precipitate being *iodide of lead.* Wash the precipitate, and filter as for the vermilion.

Lemon chrome is made by the following mixture: Three ounces of lead solution is poured into a tumbler, and two ounces of the bichromate of potash solution poured into it. Stir with a clean glass strip. The beautiful rich yellow precipitate is chromate of lead.

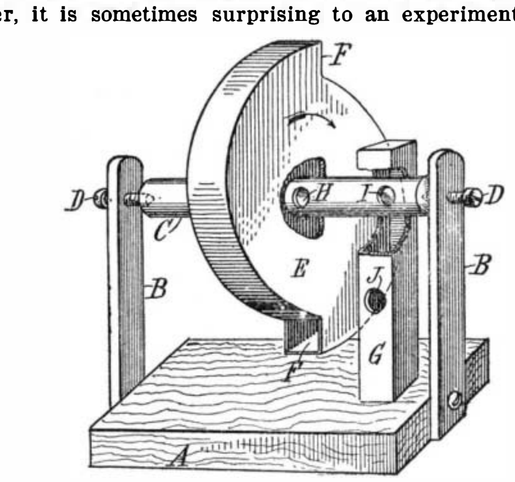
The chromic acid of the bichromate of potash has combined with the lead of the lead salt (owing to the greater affinity of these two bodies), so that chromate of lead is formed, and acetate or nitrate of potash is formed as the result of chemical combination. Wash the precipitate and filter as before, *always* using a fresh filter paper for each precipitate. Pure white, or carbonate of lead is made as follows: Pour two ounces of the lead solution into a tumbler, add about one ounce of the bicarbonate of soda solution; a dense white precipitate of pure *carbonate of lead* is formed (white lead); the precipitate being washed and filtered as before. In this case the carbonic acid, from the bicarbonate of soda, has attacked the lead from the acetate of lead solution, carbonate of lead being formed, and acetate of soda.

Prussian blue is formed by the following mixture: Take three ounces of the red prussiate of potash solution in a clean tumbler; pour into this about three ounces of the protosulphate of iron solution; instantly a dense, beautiful, rich blue precipitate is produced; stir this well; the resulting precipitate is Prussian blue. In this case the cyanogen that was combined in the red prussiate of potash has seized the iron of the protosulphate and formed *cyanide of iron,* while in the clear solution, when the precipitate subsides, is held the sulphate of potash formed by the reaction. This precipitate will take some time to subside. Never mind this; wash this precipitate as before, when it will be found that there is one of the finest blue colors produced that it is possible to obtain. A beautiful rich brick red is made by pouring into a tumbler four ounces of the nitrate of silver solution, then add thereto three ounces and a half of the bichromate solution; stir this well with a glass strip; stir it vigorously, because the precipitate is apt to be rather coarse if stirring is not well attended to. This precipitate is chromate of silver, a very permanent color, Although the term brick red is given to it, it is more of a purple red, a color in fact that cannot be produced by any other means. By preparing the above colors one's self, there is not only great pleasure derived, but a knowledge that can only be obtained by experiment.

AN INTERESTING PARADOX.

BY C. S. BOURNE.

In the demonstration of truths of a scientific character, it is sometimes surprising to an experimenter to



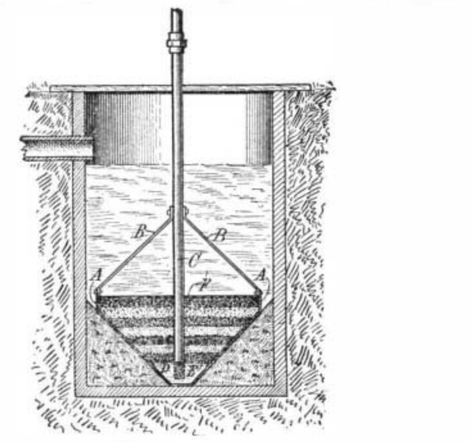
WHICH WAY WILL THE AIR FLOW?

obtain results seemingly opposed to what we conceive to be a natural sequence of means employed. Thinking it may interest some of the readers of the SCIENTIFIC AMERICAN, I give the details of a small apparatus which I constructed some time ago. As shown in the accompanying engraving, the device comprises a baseboard *A*, from which rise two supports *B B*. A hollow shaft *C* is supported at each end by means of screws *D*, threaded through the vertical supports. Mounted on the shaft *C* is a hollow drum *E*, consisting of two semi-cylindrical portions eccentrically connected to form the offsets *F* at opposite sides of the drum. These offset portions are open, and provide communication with the interior of the drum. Close to one of the supports *B* is a box or air chamber *G*, through which the shaft *C* runs. The shaft *C* is provided with an aperture *H*, communicating with the interior of the drum, and an aperture *I*, communicating with the interior of the air chamber *G*. An opening *J* provides communication with the outside air. I have asked a number of persons to predict the result of rapidly rotating the drum in the direction of the arrow (which was done in this case by drawing a cord wound on the shaft), and all have stated their belief to be that the air would be drawn into the drum, and would pass through the shaft into the air chamber, issuing from the aperture *J*. In fact, the result is a current in the opposite direction, as can readily be demonstrated by holding a piece of paper before the opening *J*. The paper will be sucked inward. The explanation, of course, is that the centrifugal force of the air in the drum more than balances the condensing power before the apertures *F F*.

FILTER FOR CISTERNS.

BY CHARLES BRECHT.

The accompanying illustration pictures a method of filtering the water in a cistern so as to make it fit for drinking. This filter may be applied to any cistern by simply filling the cistern with stone or concrete in such a manner as to get an inverted conical or pyramidal bottom. The device comprises a basket *A*, adapted to fit into this conical bottom. The basket is preferably made of sheet iron or steel of light gage, and to prevent it from rusting should be galvanized. The basket



A CISTERN FILTER.

should be attached by means of straps *B* to the pump pipe *C*. A wire screen *E* fits across the bottom of the basket, and is secured to the pipe *C* just above the perforated bottom section of the pipe. This forms a small chamber *D*, in which the filtered water collects. Above the screen *E* are placed layers of filtering material, consisting first of coarse gravel over which is laid fine gravel and then a layer of fine sharp sand. Above this a layer of charcoal should be placed; then a layer of fine sand, a layer of coarse sand, a layer of fine gravel, and finally a layer of coarse gravel. Over this is placed a coarse wire screen or perforated plate to keep the mass in place.

The idea of this arrangement is to do away with any contamination of the water by filtering it only as it is used. The wide top of the filtering basket provides a large filtering area, while the apex allows as small a volume as possible to stand in the filter basket and become brackish in case of a long drought. This small amount may be thrown away if it is found unfit for use and fresh filtered water quickly obtained, at the same time keeping as large a reserve above the filter basket as the size of the cistern will permit.

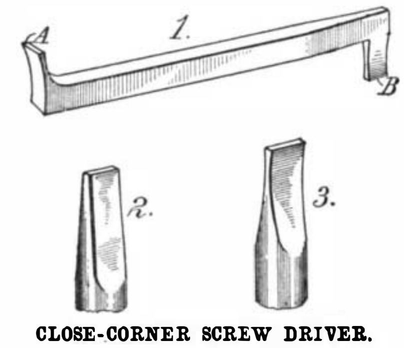
A CLOSE-CORNER SCREW DRIVER.

BY HERBERT S. DAVIS.

The screw driver here illustrated will be a welcome addition to anyone's kit of tools, as sometimes in a close space one cannot turn a regular screw driver with any degree of satisfaction, whereas with this screw driver by using first one end and then the other the screw can be tightened up nicely.

In use it somewhat resembles an angle wrench. Take a piece of ¼-inch square tool steel, about 4½ inches long, and heating it to a fair heat bend one end over and form a lip as shown at *A*, Fig. 1. Then, turning it one-quarter way round (this is done so that the other end clears the work when using) bend the other end and shape it as at *B*. Dress up the blades with a file, making them slightly hollow back of the edge of the lip which should be a good 1/64 or 1/32 inch thick. Then harden it at as low a heat as possible, and temper to a strong blue.

One need not confine himself to this size of steel. The device can be made lighter or heavier to suit various requirements.



CLOSE-CORNER SCREW DRIVER.

Right here a word on the shape of a screw-driver blade may not be amiss. Most of the screw drivers the writer has seen have lips of wedge shape as shown in Fig. 2. When made like this they have a tendency, when in use, to climb out of the slot and damage it so that it is difficult to tighten or loosen the screw.

The blade should be made as in Fig. 3, slightly hollow back of the lip. When made this way it will catch in the bottom of the slot and will not ride out.