AN EASILY CONSTRUCTED EQUATORIAL MOUNT FOR SMALL TELESCOPES.

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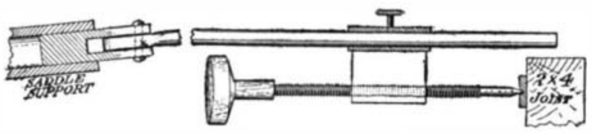
In the course of some experiments which I have been making at my summer laboratory in East Hampton, Long Island, on the photography of the moon in ultra-violet light (=3,100—3,200) it became necessary to provide an equatorial stand with a slow-motion screw for accurate following. As a polar axis is often desired in a hurry for special work, and as there are doubtless many amateurs who sometimes feel the need of such a stand, it seems worth while



THE SLOW-MOTION SCREW.

to give a short description of a very efficient, though hurriedly improvised, one which I constructed for my purpose.

It was made from the frame of a discarded bicycle, the bearings of the steering rod being, however, in good condition, with little or no lateral movement. The wheels, sprockets, saddle, etc., were removed, and the frame stood up in a wooden box, in such a position that the steering axis was approximately at the latitude angle. The box was then filled with Portland cement (1 part cement with 3 parts of clean sand and sufficient water) which was allowed to solidify. The larger places were filled with bricks and rock fragments to economize the cement. A day or two is sufficient for the solidification, after which the box can be knocked to pieces, leaving the frame rigidly mounted in a solid and very massive block. This block was placed on a small brick pier and the adjustment of the polar axis made by blocking up one end of the cement base. A short piece of 2 x 4-inch joist was lashed to the handles of the bicycle with strong wire, which served as a support for the declination axis. The rest of the stand is to be designed according to the use to which it is to be put. In my own case I required merely a device which would enable me to keep my quartz telescope pointed accurately at the moon for two minutes. From odds and ends which had accumulated in my shop the arrangement shown in the illustration was built. A short plank was mounted on the 2 x 4 on a horizontal steel axis turning in brass bearings. To the forward end of the plank a rod was fastened which passed through a wooden block clamped between the lower ends of the front forks with a small bolt. This block could be turned to suit the elevation of the telescope, and the rod fastened with a "set-screw," shown by an arrow in the picture.

Slow motion about the polar axis was accomplished by a brass rod, hinged to a larger piece of rod which fitted into the T tube which formerly carried the saddle. A small piece of brass tubing was soldered to a small piece of ¼-inch sheet brass, through which passed the slow-motion screw, sharpened to a point and turned by a small wooden wheel, made from a spool (indicated by an arrow). The brass tube and screw could be clamped at any point on the long brass rod by means of a set-screw. The point of the slow-motion screw turned in a small conical pit in a piece of brass fastened to the end of the 2 x 4 joist. The weight of the instrument being carried on the handles, that is, above the polar axis, the instrument always tended to turn (by gravity) upside down, except when pointed at the meridian. This it was prevented from doing by the pressure of the point of the slow-motion screw; and by turning the screw either forward or backward according to whether the instrument was pointing east or west of the meridian, a very uniform rotation about the polar axis was secured. A diagram of the slow-motion screw is given in the accompanying line drawing.

The instrument was set approximately in the meridian by sighting the pole star in line with the edges of the two front tubes of the diamond frame. The proper elevation of the polar axis was secured by trial, observing whether, in following the moon, it moved up or down in the field of the telescope. In half an hour I got the thing in such shape that I could keep the center of a small crater on the point of intersection of the cross hairs of the telescope for ten minutes, and as this was more than the required accuracy I let it go at that. The instrument as constructed works admirably except when pointed at the meridian. On passing the meridian the slow-motion screw is carried over to the other end of the 2 x 4 joist, this movement being allowed by the hinge at the end of the rod. When accurate following is not necessary, that is, when it is merely necessary to keep the object in the field, a more convenient arrangement would be a brass cog wheel attached to the steering rod below the handles, and turned by a worm wheel: this would obviate the trouble when crossing the meridian. It would not, however, give such uniform motion as the arrangement described, unless accurately and carefully made.

For mounting a small telescope any device can be used which will permit the instrument to swing up and down in a plane.

It is quite remarkable how well the old bicycle frame lent itself to the construction of the stand. The front forks which hold the "elevation" fixed, and the saddle tube for supporting the slow-motion rod, could hardly be improved upon if made for the purpose.

EASILY CONSTRUCTED EQUATORIAL MOUNT FOR TELESCOPES.

ALTERNATING CURRENT EXPERIMENTS.

BY FREDERICK E. WARD.

Students and amateurs who like to make electrical experiments are particularly fortunate if they have alternating current lighting service in their homes, as the alternating current lends itself especially well to the performance of easy experiments that are at the same time both amusing and instructive. Of the many kinds of experiments that may be made with simple apparatus there are perhaps no others that are more interesting than those which illustrate the principles of the rotary magnetic field and its application to electric energy meters and to induction motors.

For making the necessary apparatus there are required two similar laminated iron rings about 3½ inches inside diameter, 4½ inches outside diameter, and ¾ inch thick. These may be built up by coiling up a sufficient length of thin sheet iron strips, cut ¾ inch wide, using a round wooden block to start on. Compact iron wire bundles of about the same dimensions may be substituted with good results, or, better than either of the above, rings made up of a sufficient number of thin sheet-iron punchings. After the rings are made, all sharp edges should be rounded off with a file and a smooth covering of cotton tape be applied as shown in Fig. 1, *A*.

If there is any choice between the two rings, select for the field the one that comes nearest to being a true circle on the inside. For the winding on this ring use No. 23 or No. 24 double cotton-covered magnet wire. Have the wire on a spool small enough to pass through the ring easily, and begin at any point such as *B*, Fig. 1. Wind the wire in a single layer, with turns as smooth and close as possible on the inner circumference, until exactly one-quarter of the latter has been covered. Next reverse the direction of winding as shown at *C*, Fig. 1, and cover the second quarter of the ring by passing the spool through in the opposite direction, after tying down the little loop at *C* with a piece of thread. Make similar reversals at the half and three-quarter points, and cut off the wire near the place of beginning. This completes one-half of the winding. The second half is to be wound on top of the first half, and is to be similar in all respects except that the place of beginning must be shifted to a point 45 deg. away, as at *D*, Fig. 1.

The second ring, which is for a reactance, is to be wound with 600 turns of magnet wire of any size larger than No. 20. This winding must not have any reversals in it, all of the turns being passed through the ring in the same direction.

Lay the two rings down flat on a piece of board and make connections to a 110-volt 60-cycle supply circuit as shown in the diagram in Fig. 1, where *S* indicates a snap switch or knife switch, and *L, L, L, L* four 16-candle-power 110-volt lamps. When the switch is closed, current flows through the two windings on the field ring in such manner as to produce four magnetic poles that are not stationary but rotate

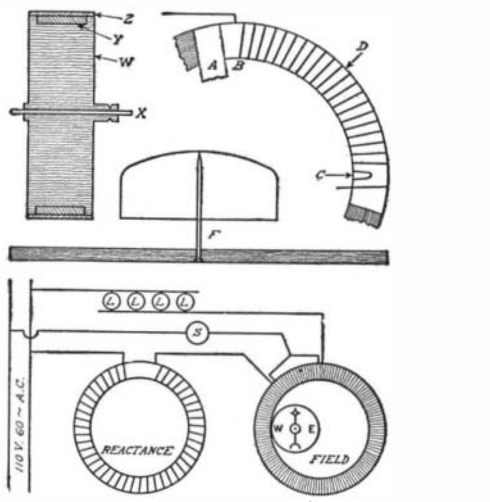


Fig. 1.—DETAILS OF THE EXPERIMENTAL APPARATUS.

or progress around the ring 1,800 times per minute. A pocket compass placed close to one side in the field as shown will rotate at this speed and illustrate the principle of the synchronous motor, in which the magnetized rotor is dragged around by the rotating magnetic poles of the field just as positively as if it were geared directly to the dynamo. If the compass be placed close to the ring on the outside, it will turn in the opposite direction. The field can be reversed by exchanging the connections to either one of its two coils.

To show the poles made by the field, lay a sheet of white paper on the ring and sprinkle some fine iron filings on it while the current is on. It is not so easy to show the movement of the poles in this way, but it may be done as follows: Shake some very fine iron filings through a piece of cloth on a sheet of paper, and then hold up the latter by one corner. The larger particles will slide off, and only the very finest will cling fast like dust. Lay the paper on the ring while the current is off, and close the switch for the briefest possible moment. Do this several times in succession, and considerable movement of the particles will be observed.

Drive a large pin through a piece of wood as shown in Fig. 1, *F*, and balance on the point a brass box cover or bell so that the latter is free to turn. If the magnetic field be then placed around the bell, the latter will be slowly dragged around by reason of the eddy currents set up therein, and will illustrate in part the principle of the driving mechanism of some forms of integrating wattmeters. Observe how the speed of the piece of brass varies in proportion to the number of lamps that are lighted at *L*.

If an iron (tin) box cover be substituted for the brass one the speed will be higher and the pull more vigorous, illustrating the principle of the induction motor. If an empty tin can be thus supported in the field, it will be rotated with considerable force and soon get off the pin. Fig. 2 shows how the field may be supported in a vertical position and provided with a better rotor, from which it is possible to get enough power to drive light toys. The details of the rotor are shown in Fig. 1, where *W* is a turned wooden support provided with a small shaft *X*, and having in its periphery an iron hoop *Y* over which is slipped a copper hoop *Z*. To be efficient the rotor must be made of a diameter as large as possible without touch-

Fig. 2.—ALTERNATING CURRENT MOTOR.