Handy Man's Workshop

The Editor of Handy Man's Workshop will be glad to receive any hints for this department and pay for them if available.

A HOME-MADE SEISMOGRAPH.

BY HENRY H. RIGGS, PRESIDENT OF EUPHRATES COLLEGE.

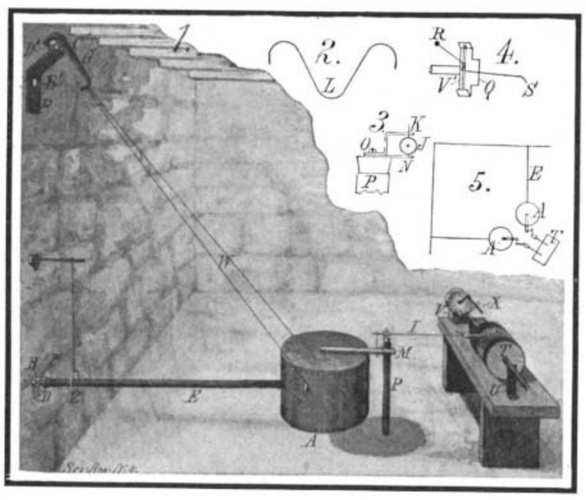
The Scientific American has occasionally told its readers something of the seismograph, and of the mysterious tremors and pulsations of the earth's crust that it reveals. But probably very few have ever seen one, or had the opportunity to "feel the earth's pulse" for themselves. Yet a really serviceable seismograph can be constructed by anyone with a mechanical head, with very few tools and a very small outlay. The following is substantially a description of the seismograph constructed by the writer at Euphrates College, Harpoot, Turkey. It involved an outlay for materials of less than three dollars. This instrument has been in operation for the past sixteen months, and has during that time recorded over one hundred and sixty earthquakes. The construction of the instrument is shown in the accompanying engraving.

The Steady Mass.—The fundamental part of the instrument is a horizontal pendulum, whose function it is to remain at rest during an earthquake. The mass is a sheet-iron drum, *A*, full of gravel, weighing about eighty pounds. This is fixed securely to the end of a one-inch iron pipe, *E*, whose other end rests, by a frictionless bearing *C*, against a solid wall. The drum is also hung from the wall by a similar bearing at *C'*. The bearings are made as follows: The half-inch machine bolts, *B* and *B'*, turn in nuts which are very firmly imbedded in the wall. In a slight depression in the head of *B* a quarter-inch bicycle ball, *C*, is set, with wax. Against this ball rests a polished, hardened steel plate, *D*, slightly concave, which is tacked to the hardwood plug driven into the end of the pipe *E*. The upper bearing ball, *C'*, is set in a depression in the bent bar *F* (1½ x ⅜-inch iron) which is firmly clamped to the wall by the bolt *B'*. The concave steel plate *D'* is cemented to the iron stirrup *G*. The other end of the stirrup is formed into a hook, over which passes the suspending wire, *W*, whose ends are fastened to the ends of the rod *H H'*, which passes through the drum *A*.

Adjustment of the Steady Mass.—By tapping the bar *F* to one side or the other, the bearing *C'* is brought exactly over *C*, so that the pendulum swings out perpendicular to the wall. The bolt *B* is then turned in or out, to regulate the period of the swing. The pendulum, when disturbed, should swing back and forth once in forty or fifty seconds. Turning the bolt *B* inward shortens the period, turning it outward lengthens it. If *B* is too far out, the pendulum will not swing back and forth, but will swing clear over to either side. As it is impossible by moving the plate *F* to adjust the pendulum very exactly, a weight, *Z*, of two or three ounces, is hung by a long thread against the strut *E* a few inches from the bearing. The support from which this weight is hung can be adjusted, so as to bring more or less pressure on the strut as needed.

Multiplying Lever and Recording Pen.—To the steady mass is connected the short arm of the multiplying lever *I*. The short arm consists of a bit of brass wire, No. 12, three inches long. It is inserted into the cork *J* (Fig. 3) which serves to join together the two arms of the lever and their pivot, *K*. At one inch distance from the pivot the brass wire is flattened slightly on top, and a conical depression is made in it. In this depression rests one point of a link, *L*, of fine piano wire, shaped as in Fig. 2. The other end of the link rests in a similar depression in the brass bar *M*, which lies on the pendulum drum. This link communicates any motion of the drum to the short arm of the lever *I*. The long arm of the lever is a stout straw, fourteen inches long. The short arm should nearly balance the long one; if necessary, a drop of solder may be added at the end of the wire. At the end of the long arm is a cross-piece, *Q* (Fig. 4), of aluminium foil, whose two ends are bent up to form a support for the needle, *V'*, whose pointed ends rest in depressions in the foil. A piece of No. 24 aluminium wire is given two turns about the needle *V'*, and cemented to it. One end of the wire, an inch long, is ground to a conical point, *S*, and bent downward so that the point rests on the drum *T*. The other end is bent up and to one side, and cut off half an inch long. A drop of wax, *R*, makes this short arm nearly balance the point. Thus when the point is down, it rests on the drum very lightly, and when swung up, the short arm does not touch the drum. The pivot, *K* (Fig. 3), is a common sewing needle, rather fine, whose point rests in a conical depression at *N*, while the upper end passes through a fine hole in the sheet-brass yoke, *K O N*. The latter is fastened with a screw to the top of the post *P*, which is an iron pipe, firmly planted in the ground, with a hardwood plug driven into its upper end.

Recording Drum and Clock.—The recording drum is a cylindrical tin can closed at both ends, with a quarter-inch shaft fastened in its exact axis. The drum must be perfectly balanced on its axis by adding wax or solder to one side or the other. The shaft rests on uprights, *U*, of thick strap iron, which are



A HOME-MADE SEISMOGRAPH.

fastened to the table on which the recorder is mounted. A screw thread of about thirty turns is formed on one end of the shaft with a soft brass wire, wound spirally and soldered at each end. This thread engages the upright, *U*, and drives the drum slowly forward as it rotates. The clock is an ordinary one-dollar lever clock. It is firmly fastened on the block *V*, on the table, so that its axis is exactly in line with that of the drum *T*. The L-shaped iron wire *X* is soldered along the minute hand, and also to its bushing and pivot, so that it will rotate rigidly with the minute hand. The long arm of the L is parallel with the axis of the drum, and is engaged by a fork soldered to the end of the shaft. Thus the drum rotates with the clock, but moves gradually along its axis. On the drum is wrapped a sheet of white glazed paper, held in place by an open ring of spring wire slipped over each end of the drum. The paper is blackened by revolving the drum over a large, smoky flame, such as a kerosene torch.

Important Details of Construction.—Exact dimensions are unimportant. The drum *A* is one foot in diameter. The following points, however, are of vital importance:

1. The wall from which the pendulum is hung must be exceedingly solid. If possible it should be below ground, and not subject to great and changing strains. A lengthwise displacement of the millionth part of an inch in the upper part of the wall makes a perceptible jog in the record. Short-period tremors, however, such as machinery or cars near by, do no very serious harm.

2. The steel bearing plates, *D* and *D'*, after being shaped with a smooth, slightly concave surface, should be tempered file-hard, and then the bearing face highly polished with leather and fine emery.

3. The bearings of the lever *I*, the link *L*, and the stylus *R S* must be very perfect. The points of the needles, *K* and *V'*, and of the link *L* must be perfectly sharp and smooth. The conical depressions in which they rest may be made by pressing into the metal a sharp-pointed awl with a whirling motion. In regions where sharp earthquakes are sometimes felt these depressions should be rather deep, to prevent the points flying out. The needle *K* must be exactly vertical.

4. As most of the friction of the seismograph is at the point of the stylus *S*, it is of the utmost importance that that stylus should rest very lightly on the paper, only heavily enough to scratch through a moderately thin soot layer. The broad part of the cross-piece *Q* should be bent upward, so as to prevent the stylus dropping too far when the pen swings off the paper in a great earthquake.

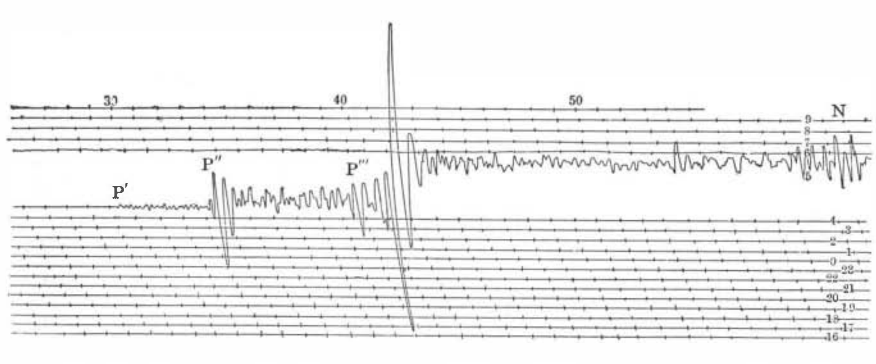
5. If there are drafts in the room where the seismograph is installed, the instrument must be well protected from them.

Time Marking.—To be of scientific value, the records should have exact time marked on them at frequent intervals. This can easily be done if a reliable clock is available. A bit of platinum wire soldered to the second-hand wheel makes a short contact once each minute with a fixed platinum wire. These contact points are connected, through two dry cells, to the magnet of an electric bell. (Directly, not through the vibrator.) The bell, with gong removed, is rigidly attached to the post *P*, so that the strike of the armature is at right angles to the lever *I*. Thus at the end of each minute there is a sharp click against the post, which causes, as it were, a miniature earthquake, which is plainly visible in the record. The effect is improved if the clapper of the bell be replaced with a lead weight of two or three ounces.

Records.—Once in twenty-four hours, after marking on the smoked paper the exact time at the last minute mark, the paper is carefully removed, a fresh sheet put in place and smoked, and the clock wound. First the beginning of each hour is marked, and on the top line a mark is made at every tenth minute. The date, ratio of magnification, and clock error are also noted. All these are scratched in the soot on the sheet. The record is then fixed by brushing rather thin varnish over the *back* of the sheet. If a register is kept, at least the following data should be entered in it: 1. Time of the beginning of first preliminary tremors, P'. 2. Beginning of second preliminary tremors, P''. 3. Beginning of the first group of large or principal waves, P'''. 4. Time of maximum motion. 5. Amplitude of maximum motion. (Measured from position of rest of pen to extreme of motion to either side. This should be divided by the ratio of magnification of the lever *I*.) 6. Period at time of maximum. (I. e., time from one crest to the next of the largest waves.) 7. Time of end of principal portion. 8. End of succeeding tremors.

Locating a Distant Earthquake.—The writer has been able, in the case of large, distant earthquakes, to announce the general location of the shock at once, from the records of the seismograph. Two elements are needed for this—the distance and the direction. As the first preliminary tremors travel much faster than the main, large waves, the difference in time of their arrival gives a measure of the distance of the origin. Various formulæ have been computed for this, some of them very complicated. The writer has found, however, that a uniform rate of three degrees per minute is not far from the truth, for all distances; that is, for every minute that elapses between the beginning of the first tremor P' and the beginning of the first group of large waves P''', measure three degrees of distance on a great circle of the globe. That will generally give within ten per cent of the correct distance.

To determine the direction of an origin, a single horizontal pendulum is inadequate. There must be two, set at right angles to one another, so that by compounding the two co-ordinates thus given, the actual direction of the earth's movements may be seen. The diagram Fig. 5 shows one method of bringing the records of two pendulums on one recording drum. The short arm of each recording lever is set at an angle of 135 deg. to the long arm, thus bringing the long arms parallel, as shown. One pendulum hangs north and south, and records motions of the earth east and west, while the other records motions north and south. To determine the direction of an earthquake origin, attention need be given only to the very first one or two waves of the preliminary tremors. It is known that the first preliminary tremors are waves which, like sound waves, move in a direction parallel to the line of propagation, while the main waves have a motion at right angles to this, like light. The latter, however, are exceedingly complicated waves, while, so far as the writer has observed, the first preliminary tremors always begin with a very slight motion away from the point of origin, followed by a considerably larger swing toward the origin. So that whenever the beginning of these tremors is strongly recorded it is possible, by comparing the north-south and east-west components of these first motions, to ascertain the direction from which the waves have come. This, with the distance, marked out (on the great circle) on a globe, gives the approximate location of the earthquake.



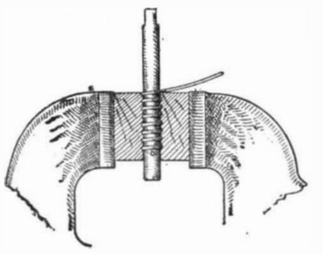
A DIAGRAM OF THE BOKHARA EARTHQUAKE RECORDED BY THE HOME-MADE INSTRUMENT AT HARPOOT, 1850 MILES AWAY.

N. B.—The writer wishes to acknowledge the assistance, in constructing this seismograph, of Prof. Marvin, of the Weather Bureau at Washington, and Prof. Milne, of the British Association Seismological Committee. Both of these gentlemen have very courteously answered questions on the general construction of such instruments.

A SIMPLE METHOD FOR MAKING A COILED SPRING.

BY A. FAGAN.

Get a metal rod the same diameter as the spring desired; drill a hole near the end to admit end of wire. Give the wire two or three turns around rod, spacing the turns according to the desired pitch.



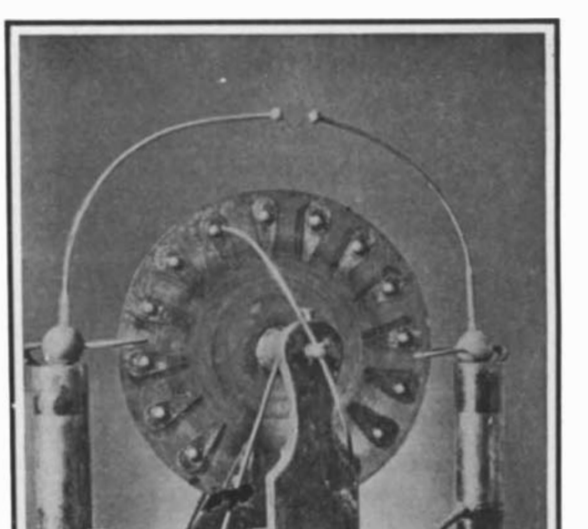
A SIMPLE METHOD FOR MAKING A COILED SPRING.

Clamp it between two blocks of hard wood in a vise, having the rod in the direction of the grain of the wood. Revolve the rod by means of a monkey wrench fitted on flattened end of rod. The wire will follow in and wind a spring as true and perfect as though it had been wound with a lathe.

A HOME-MADE WIMSHURST MACHINE.

BY JOHN R. ALLEN.

I became acquainted with two students, who were each intending to build a large Ruhmkorff's induction coil for experimental purposes. I was taking the Scientific American at the time, and had been reading about the Wimshurst machine. I noticed that it is very simple and cheaply made when compared to a large coil. I told the young men of it, and showed them the papers, and asked them why they did not build Wimshurst machines instead of coils. After several visits to their workshop and continued efforts to get them interested they "turned the tables" on me and said, "Why don't you build a Wimshurst machine?" And then they began to "rub it in" and repeat all I had said to them, and also hinted that I could not make one that would spark at all. I saw I would either have to build a machine or admit defeat and stand the laugh. So I went to work to build one. I did not go strictly according to the directions as laid down in the Scientific American Supplement No. 548. I built the frame of oak, made the bosses of pine, got the two glass disks cut, 12 inches in diameter, used brass foil with brass hemispheres (tack heads) soldered on for sectors, sixteen on each disk. Instead of bottles for Leyden jars I used Welsbach gas lamp chimneys (the straight kind), putting the tinfoil in the middle, keeping it 1½ inches



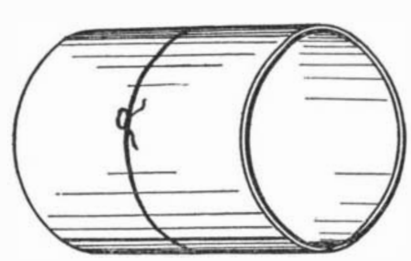
A HOME-MADE WIMSHURST MACHINE.

from each end, and then I put the posts that support the combs and terminals right through the chimneys. The posts are of hard rubber. I bored a hole into the end, and put the stem of the brass balls which connects the combs and terminals into it, and poured melted sulphur around it till the hole was full, and it makes a good fastening. The combs are connected to the inner coating of the Leyden jars. In place of simply connecting the outer coatings of the jars together with a wire, I put two tubes into the frame in such a manner that I can connect them by putting the plug in one tube, or I can disconnect them by putting it in the other, and then put in hand bolts or any connection I like. I can also put wire in, and run it to display designs made by tinfoil strips cut at the places where the sparks are wanted to make the design or letters, etc. I used oak driving pulleys and leather cord belt. I get a 1½-inch spark when the outer coatings of the jars are connected. I photographed the machine, spark and all, by pulling down the window shades, opening the camera, and then turning the machine till it sparked several times, closing the camera, raising the window shade, and taking a picture of it in the daylight.

The students made their coils, but one of them broke down in three months and had to be rewound.

A BLACKSMITH'S NAPKIN RING.

A blacksmith friend recently presented the writer with a very neat dinner napkin ring, which he had made from an old steel shovel. A strip of steel was cut the proper length and width. The two ends were tapered down until their combined thickness was equal to the thickness of the body of the ring, which was bent into a cylindrical shape, and held in position by means of a piece of iron or steel wire wrapped around the outside. Since the steel was too thin to be welded, on account of losing the heat too quickly,



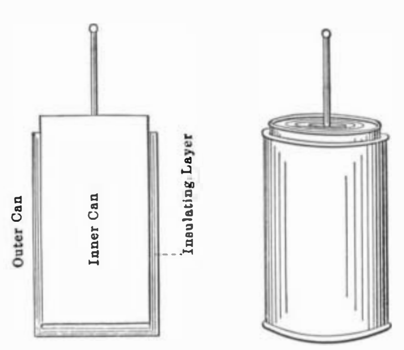
A BLACKSMITH'S NAPKIN RING.

the two ends were brazed. A thin flat piece of copper wire was put over the joint, and the ring placed upon the fire, with the joint nearest the heat. As the ring became hot, a pinch of powdered borax was thrown along the inside of it, over the joint, bringing the copper wire to the melting point, when the ring was quickly but carefully taken from the fire and dipped into a pail of water. The surface of the ring was cleaned up bright, and sent to a silversmith to be plated.

AN UNBREAKABLE LEYDEN JAR.

Two ordinary tin cans may be used to make a serviceable Leyden jar, which has the advantage of being unbreakable, according to Kosmos.

Select two tins such that the diameter of the one exceeds that of the other by about one-half inch. Cover the bottom of the larger tin (inside) with a disk of rubber or varnished cardboard. To the bottom of the smaller tin (on the outside) solder a piece of iron or copper wire, bent into a hook at the tip, or else ending in a ball. Around the smaller tin wind an old rubber plate or several layers of silk rags or well-varnished parchment, folding this insulating layer down into the tin over the edge, an inch or more. Place the smaller tin, thus insulated, with the edge down, in the larger can, and the Leyden jar is com-



AN UNBREAKABLE LEYDEN JAR.

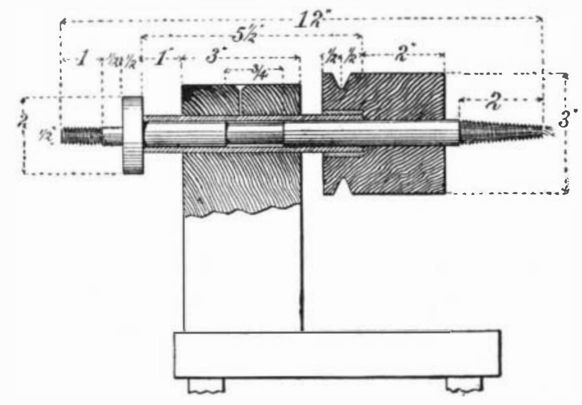
pleted, ready to be charged from a frictional machine or an electrophorus.

The inner tin should stand out an inch or so above the outer can, to prevent sparks from passing over.

A SIMPLE FOOT-POWER COMPOUND GRINDER.

BY A. E. OSBORN.

As there may be some amateur mechanics (particularly automobilists) who do not possess a grinding and polishing machine, although they would find such an appliance of considerable use, it is thought that the accompanying description and illustration of a machine made by the writer in about an hour's time and at practically no expense, might be of interest. The cheapness and ease with which it can be made are due to the utilization of certain parts of a bicycle (which is usually available or can be obtained for a small sum second hand) for the driving mechanism, and to the employment of a convenient work bench or strong table as a stand. The bicycle should have as high a gear as possible (it is not injured, and can be reassembled and used on the road again) and should have its front wheel, forks, handle bar, and back tire removed. In order to support the remaining parts, two boards about 1¼ x 4 inches, reaching from the floor to the top of the bench, should be pro-



DIMENSIONS OF THE GRINDER HEAD.

vided, and these should each be drilled 16 inches from the bottom with a hole of a size to fit tightly on the nuts on the ends of the rear axle. These boards should be nailed to the floor on each side of the rear wheel, and nailed to a board at the top, so as to clamp the bicycle frame tightly between them, with the axle in the holes previously mentioned. This board should be firmly fastened to the top of the bench, and should be long enough to bring the grinding wheel in a convenient position, while its width should be sufficient to cover the tops of the axle supports. An upright board should support the head of the frame, so that the pedals will clear the floor by about 2 inches. The grinder head, used with this foot-power device, consists of a block of wood about 3 x 3 inches fastened firmly on to the top board by nails or screws, and of sufficient height to bring the grinding spindle to the desired position, a brass bushing which is of about ½-inch iron pipe size tightly fitted in a hole in the top of the block, a grinding spindle, and a grooved wood pulley. The spindle is the only piece requiring lathe work, and even this may be eliminated by using a straight rod (the bushing tube being of a size selected to fit it) and very carefully threading it with a ½-inch 12 die for the collar and clamping nut. It is, however, much more satisfactory to have a turned spindle, as it can then be made a better fit in the bushing, and the inner collar and part carrying the wheel can be turned true with this bearing surface. The part of the spindle that goes into the inner collar should be made a drive fit in the collar, and the latter should be turned while in place on the spindle. A nut and large washer should be provided for clamping the grinding wheel on the spindle. The other end of the spindle is formed with a threaded taper for polishing and buffing wheels, although it would be cheaper to leave it blank. It could also be arranged to carry a second grinding wheel if desired. The pulley which goes on this spin-

A SIMPLE FOOT-POWER GRINDER.

dle is cut (if possible turned) out of a piece of hard wood, and is bored so as to make a tight fit on spindle. If it should show any tendency to slip, a set screw can be run through it and against the spindle. This completes the machine with the exception of a ⅜-inch leather belt, a grinding wheel (¾ x 6 inches is a good size) and, if desired, a tool rest which can be rigged up around the wheel.