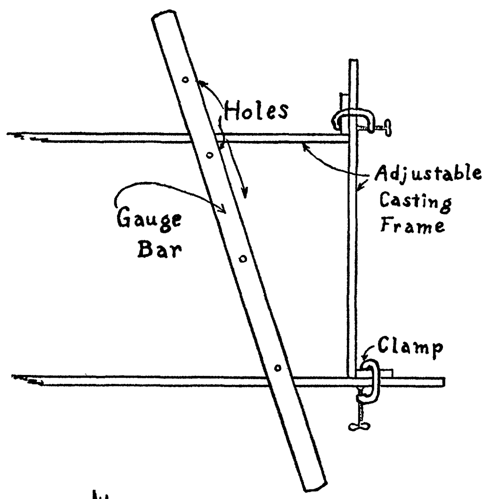


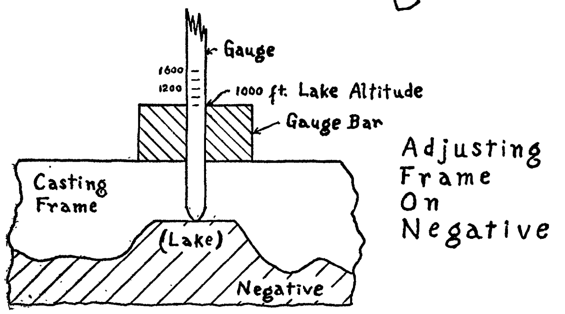


hundred feet lower and set the tool to throw the sand away from the hill as the pointer follows along the line. It may be necessary to turn the tool as the direction of the line changes. Much care is required to avoid breaking down steep hillsides or narrow ridges. Experience will develop the proper technique. The minor ravines are best done free hand, using either the spoon or the molding tool after determining accurately their positions. If the sand becomes dry and crumbles it must be moistened by careful sprinkling. When the model has been formed, the loose sand grains at the surface should be pressed down with the fingers, being careful not to destroy any part of the work, or to leave concave finger imprints. A thin mixture of plaster of Paris may now be poured gently over the model to a depth of about an inch, or until the hill tops are well covered. The amount necessary will be governed to some extent by the nature of the relief. When it has set firmly it should be loosened from the sides of the box and removed by lifting out the false bottom. The sand may now be cleaned from it by scraping and brushing.

The final cast is made in an adjustable frame. The one used by the writer consists of four separate side pieces, each with a flange at one end by which they are clamped to each other with small clamps. This frame fits closely around the plate or negative, and is supported independently. A gauge is used to adjust the height of the frame. Test the adjustment by sighting across the edges. They must all be in the same plane else the completed cast will not rest on an even base. The surface of the mold must be coated with vaseline or similar substance to prevent the cast from sticking. Fill the frame with plaster of Paris mixed thin enough to fill readily the inequalities of the mold. Use a straight-edged board to smooth the top even with the edges of the frame. Oftentimes it will not be necessary to fill the center of the frame to this level. Use only enough plaster to insure adequate thickness and strength. When dry, the cast may be cleaned and painted in any desired manner.

An important feature of this device is that the completed model has the same horizontal scale as the map from which it is taken. If a pantograph is used to guide the molding tool, the model may be made either larger or smaller than the map, but it is not convenient to reproduce the same scale. The writer has used a large pantograph in this way to increase the scale of models made from maps. It is a satisfactory method, except that the enlarged model calls for a corresponding increase in detail not shown by the map.

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## AN OSCILLATOR AND SYNCHRONOUS MOTOR FOR OBTAINING EXACT VARIABLE SPEEDS

WHERE it is desired to have a shaft or disc rotating at a single exact rate, the synchronous motor, following the oscillations of an alternating current, gives an extremely high degree of accuracy. The type of motor employed in electric clocks and that recently described by Wilkins[1] serve that purpose. However, it is often necessary to have the rate of rotation exact, but capable of rapid and convenient variation. The clock motor, though designed to operate on 60 cycle alternating current, can be made to run and vary its speed over a fairly wide range if operated from the output of an oscillator of variable frequency.

The construction of such an oscillator is shown in Fig. 1. A screen grid tube, Type UX-222, is employed as a dynatron in a circuit of the parallel tuned type. This kind of oscillating circuit has the advantage of stability greater than that afforded by the ordinary type of vacuum tube oscillator.[2] If the proper capacities and inductances are used variation of frequency over a wide range is possible. Small inductance, capacity, or both, yield high frequency; lower frequencies are obtainable by the use of larger

[1] H. S. Wilkins, *Gen. Rad. Experimenter*, 1930, 5, No. 5, 3–7.

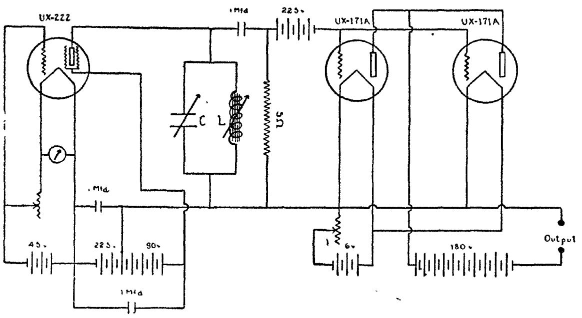


FIG. 1.

inductances and capacities. The frequency in cycles per second is approximately given by the relation: $f = \frac{1}{2\pi\sqrt{LC}}$ where L is the inductance in henries and C is the capacity in farads. A convenient arrangement, if not too great variations of frequency are desired, is one using a constant inductance such as that supplied by the primary of an audio-frequency transformer and variable capacity supplied by a battery of fixed and variable condensers joined in parallel by appropriate keys. A gross change in range may be effected by tapping the inductance or increasing the original amount. If greater accuracy is desired a coil of three or four henries may be wound and substituted for the transformer. Since the frequency of the oscillating circuit is not independent of the voltage supplied to the filament of the screen grid tube it is well to insert a voltmeter in the filament circuit. Maximum efficiency is achieved by operating the filament at the rated 3.3 volts.

The power to run the clock motor is secured from a series of UX-171A tubes in parallel, two being sufficient to take care of small motor loads. Most synchronous clock motors draw about 2 watts; this makes possible the use of dry cell batteries as sources of power. The A and B voltages of the power stage and oscillator have been taken from separate sources, though this is doubtless an unnecessary refinement. With the usual modifications of the circuit, operation would probably be quite satisfactory with A.C. for filament voltage and rectified A.C. for B and C supply. In order to operate the clock motor it is necessary to allow the D.C. as well as the A.C. output of the tubes to flow through the stator windings.

As is necessary in the operation of all synchronous motors, the clock motor is started by spinning the shaft until the motor falls into synchronism at either of two fractions of the impressed frequency, the one being twice the other. These are not difficult to discriminate, since they depend upon the starting torque. In our arrangement the primary shaft has been made to turn at speeds varying from 250 to above 700 r.p.m. without running at multiples. A greater range would be entirely possible, though this is sufficient for most purposes, since gross changes may be effected by gearing the shaft up or down.

Calibration of the oscillator is best effected by substituting an electric clock for the motor in the output circuit. If this is allowed to run ten minutes, for example, with the oscillator at one setting and its rate of motion, as indicated by the hands, be compared with that of an ordinary timepiece, the frequency of the oscillator can be computed with great accuracy.

The apparatus described was developed for use in an experiment on the critical frequency of flicker, where the speed of rotation of a sectored disc must be changed by exactly known amounts. Other uses are apparent. As just described, the method is an excellent one for determining frequency. The rotating disc could be supplied with a contact to interrupt a circuit at definitely variable intervals. The frequency of a second oscillator could be calibrated over a range much higher than the first by connecting the second oscillator to a neon bulb and making it produce a stroboscopic pattern on a disc rotated by the first.

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# SPECIAL ARTICLES

## A FLOWERING CYCADEOID FROM THE ISLE OF WIGHT

FOLLOWING the notes on the petrified "cycad" trunks of the Isle of Portland given by Dr. Buckland with the advice of the famous botanist, Robert Brown, a hundred years ago, the definitive knowledge of the cycadeoids or flowering cycads begins with Carruthers' description of *"Bennettites Gibsonianus"* from Luccomb Chine on the southeast shore of the Isle of Wight, in 1870. Just when these stem-bearing mature cones were first seen is not so sure. In Wilkins' "Geology and Antiquities of the Isle of Wight" of 1859, there is mentioned as coming from Sandown (a Wealden shore), "an interesting specimen in a nodule with a fracture across it, exposing its fructification with seed vessels, discovered by my friend T. F. Gibson Esq." This is likely the Carruthers type, despite any discrepancy as to locality or horizon;

[2] C. E. Worthen, *Gen. Rad. Experimenter,* 1930, 4, No. 12, 1–4.