THE CECCHI SEISMOGRAPH. A NEW MODEL CONSTRUCTED FOR THE OBSERVATORY OF MANILLA.

(Translation of a paper received from Father Federico Faura S. J. of Manilla.)

BY

DR. F. DU BOIS.

[READ JAN. 26TH 1885].

All the parts composing this seismograph are collocated on a large marble tablet solidly placed upon a substructure so constructed as to prevent all oscillations save those which are truly seismical. The lower edge is 50 centimeters from the ground and the surface is perfectly perpendicular.

On the surface of this marble slab are attached five different machines which when combined or acting together compose the new apparatus and give automatically *1°*warning, *2°*time, *3°*directions and *4°*intensity. These five machines are,

First a steel spiral with its weight (M) which puts in motion the whole apparatus.

Second a clock which gives *warning*, the *time* of the shock and *puts in motion* the roll of smoked paper.

Third the horizontal pendulum (P) which describes the oscillation on the smoked paper.

Fourth the vertical pendulum (S) which describes its own oscillation.

Fifth the cylinders (C C') for unrolling the smoked paper

The clock is fixed on the highest part of the slab and governs all the apparatus. To its right stands the motor apparatus (M) to its left the horizontal pendulum (P). Below this are the cylinders for running off the smoked paper. To the side of the larger of these two and right under the clock is the vertical pendulum.

The Motor apparatus (M) is composed of a weight of lead (*m*) suspended by a strong steel spiral. From the said weight

a silk thread passes upward through the spiral and over a pulley (*c*) to a small brass spiral (*o*) which serves as a counter weight and keeps the pulley in place.

From the center of the pulley rises an arm or lever cut almost to a knife like point (*a*). On the edge of this rests a similar point which is screwed on to the longer arm of a lever (*l*). To the opposite arm of this lever is attached a fine string (*f'*) which goes downwards to be attached to the middle lever (*i*) and to the left of its fulcrum. So as to enable both the knife like edges at (*a*) to rest upon each other exactly, the counter spiral (*o*) must be properly regulated which is done by moving the screw which controls it.

The weight of this horizontal and vertical pendulum has on its under side a tube of brass (*t*) which can be elongated. Over the aperture of this, a piece of fine unstarched linen is stretched. This piece of linen is punctured by the superior external horn of a brass ring (Fig. 3) which brass ring by means of two other interior projections one from above the other from below, rests upon a horizontal lever and again this same brass ring by means of another external projection down wards rests upon the extremity of the screw (*v*). Both this screw and the horizontal lever (*r*) are moveable in order that the ring may be placed in a position vertical to the horizontal pendulum. At the extremity of this last lever is attached a third little silk thread (*f''*) which is united also with the intermediary lever to the right of the fulcrum.

Against the extremity of the long arm of the intermediary lever rests a small brass plate (*n*) to the extremity of which is attached a thread (*f'''*) which passes behind a fixed "point" to which the plate is attached and is prolonged as far as the lever of the clock (O) and operates upon the balance wheel of the same.

The time weight (P) runs between four iron wires in order to prevent interference with other pieces of the seismograph.

The cord of the weight causing the clock to strike passes around a pulley just above the great cylinder C, then around another pulley behind the great cylinder C and comes down to

the weight (p'). On this cylinder are three springs or regulators by means of which the paper is kept in place.

The paper thus rolls from the big cylinder and over small one (C') and is held in place and tightly drawn by the weight of two nippers made for this purpose.

On the left of the clock is attached the horizontal pendulum with a kind of universal joint. (Fig. 2).

The weight of this pendulum has above it a disc of brass covered with smoked paper. Working on this there is an ivory point fixed to a very light and balanced lever which moves upon a little arm (b) fixed to the marble slab.

Below the weight is attached still another lever similar to the preceding one the point of which rests on the smoked paper which rolls on the cylinder.

Below the clock and alongside the cylinders stands the sussultory pendulum consisting of a weight which rests between the prongs of a fork the other extremity of the fork being attached to a fixed point. The weight and the fork are suspended by a spiral (s') attached to a fixed point above. Above the spiral there is a shaft bearing a pulley (c'). A vertical prolongation is attached to this shaft and a horizontal piece hinged to a fixed point is attached to the lower end of it. One end of this rests on the smoked paper. By this means a lateral motion on the paper corresponds with a vertical motion of the pendulum (m'). In order to put the instrument in readiness to work it is necessary.

(1) Place the inferior point of the ring (2) on the point (v)
(2) Place the blades of the superior lever one above the other.
(3) Lay the brass table (n) on the intermediary lever (1) in order to keep the system of wheels of the clock in statu quo
(4) Blacken the paper and adjust the three points in contact with the same.

In order to blacken the paper it is necessary to take off the weight of the clock and lift up all the writing points.

The paper is then all wound upon the great cylinder—then slowly unwound while a light affording smoke is placed

beneath. When all the paper is smoked it is wound on the big cylinder again.

Every thing being in order if there is a horizontal motion, at the least shock, the motor pendulum throws off the vertical the ring (3) which no longer having its point of rest on the point of the screw (*v*) falls by its own weight and lowers, the lower lever (*m*) to which its is united. The lower lever by means of the thread draws down intermediate lever (*i*) and the little table (*n*) which rested upon it falls and sets free the works of the clock. The hands of the clock then move, the clock rings, the bell weight descends and moves the cylinder and the paper rolls off.

At the same time the undulatory pendulum moves and the point attached to it traces on the paper all the movements to which the pendulum is subjected.

These motions are also recorded on the circular smoked paper placed above the weight of the same pendulum.

If the motion had been sussaltory and the point placed on the screw (*v*) did not move, then the apparatus would be put in motion by means of the upper part. At the first oscillation of the pendulum the little sping (*o*) would force the pulley (*c*) to rotate.

This would put the lever out of equilibrium and by its connection with the intermediary lever, again the clock would be started.

If the shock were vertical and the big pendulum did not move, the apparatus just under the clock will be brought into play. As the weight rises and falls the little string attached to it will turn the pulley. This rotates the shaft and the point which is fixed to it will record on the paper the vertical motion of the pendulum (*m'*).

After a shock it is necessary to put everything back to its original position in order to have the apparatus in readiness for a second shock.

The smoked paper is removed and fresh paper is put in its place and the operation of smoking has to be done again.

The irregular marks upon the paper are due to oscillations of the earth and indicate direction and the intensity.

Motions with a gradually decreasing amplitude are due merely to the normal oscillation of the pendulum acquired by the shock.

The curves which may be found traced upon the disc above the pendulum serve to indicate at first sight the direction of the shocks and their intensity—while the paper below which unrolls enables us to see all the phases of the phenomena in all its various movements.

The observer should note the relative time which the horizontal and vertical pendulum take in oscillating in order to establish the just relation between the two movements as written on the paper.

In order to blacken the little paper above the weight it is only necessary to turn it toward the light and pass the lamp forward and backward till it is black enough.

The direction of the meridian may be marked upon the diagram.

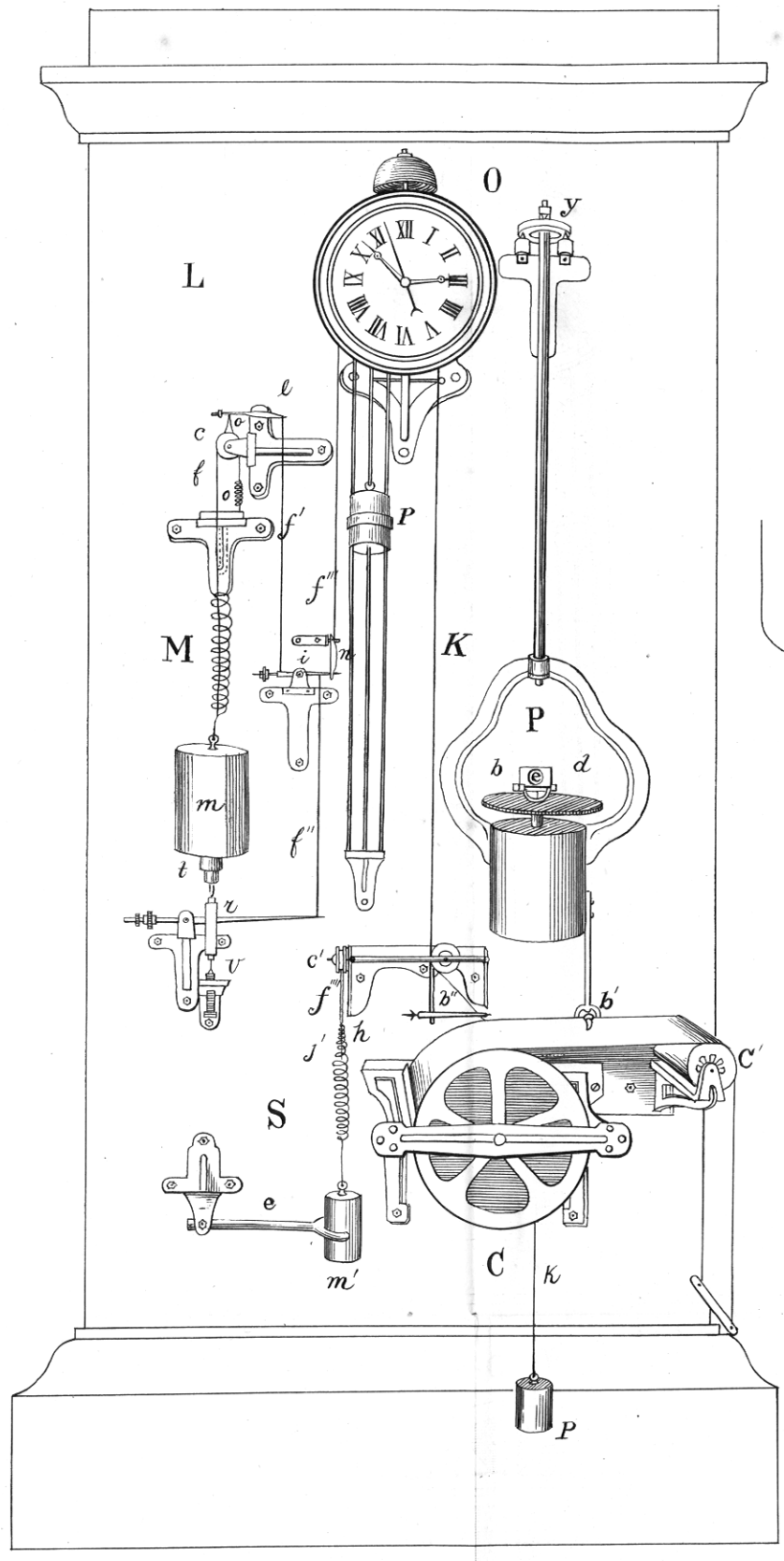

FIG 1

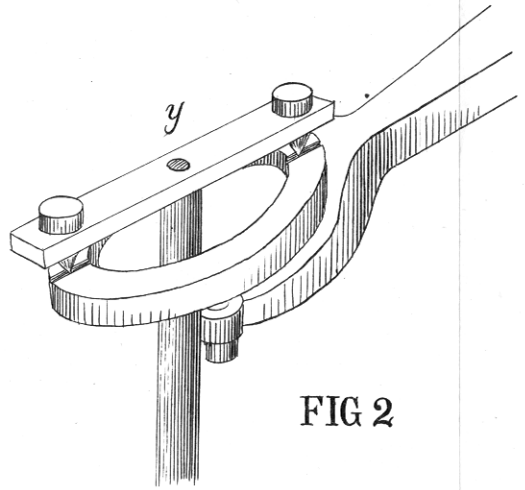

FIG 2

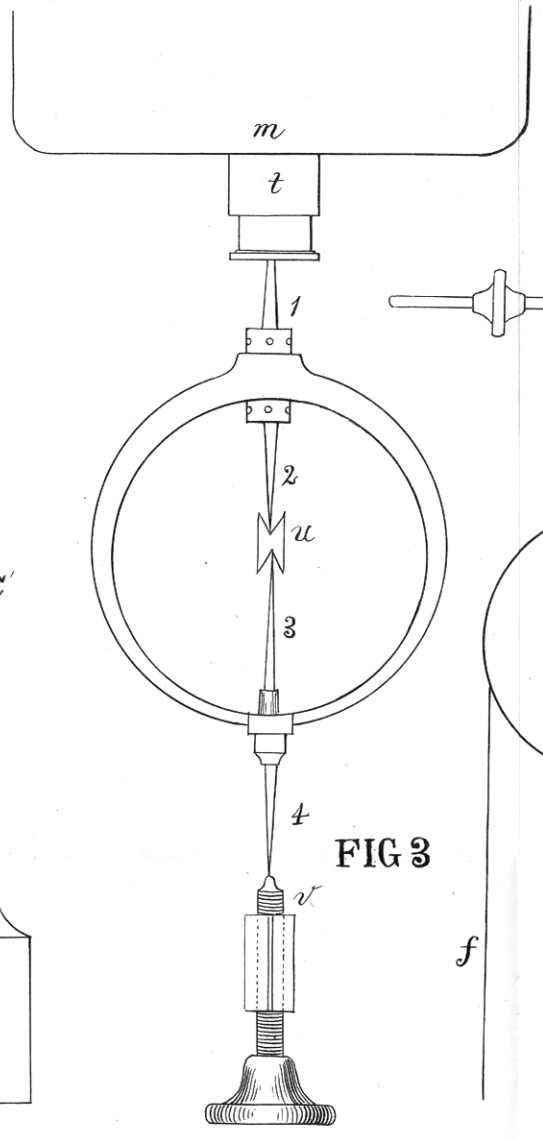

FIG 3

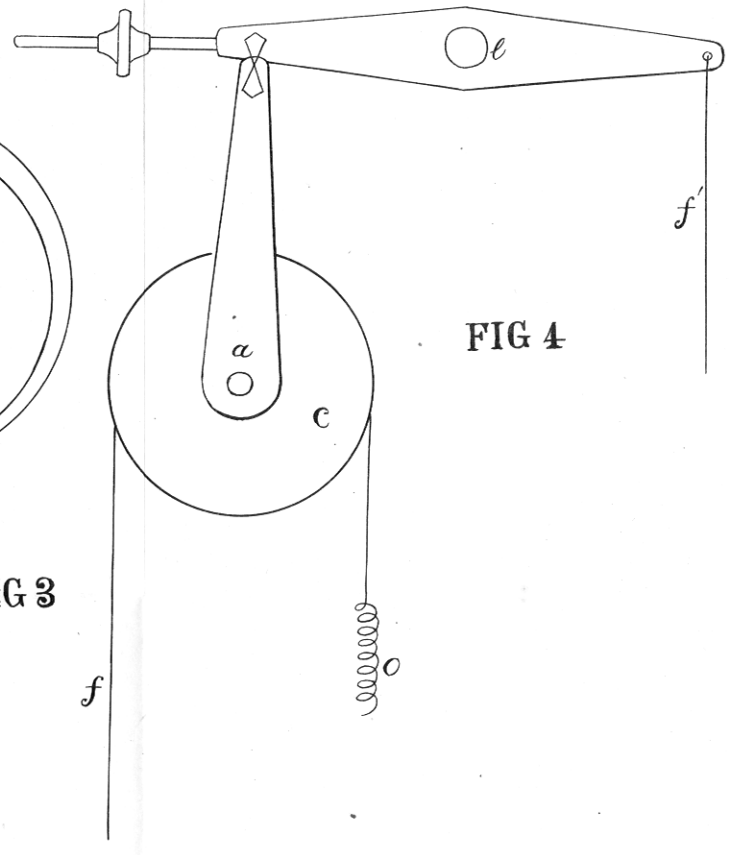

FIG 4

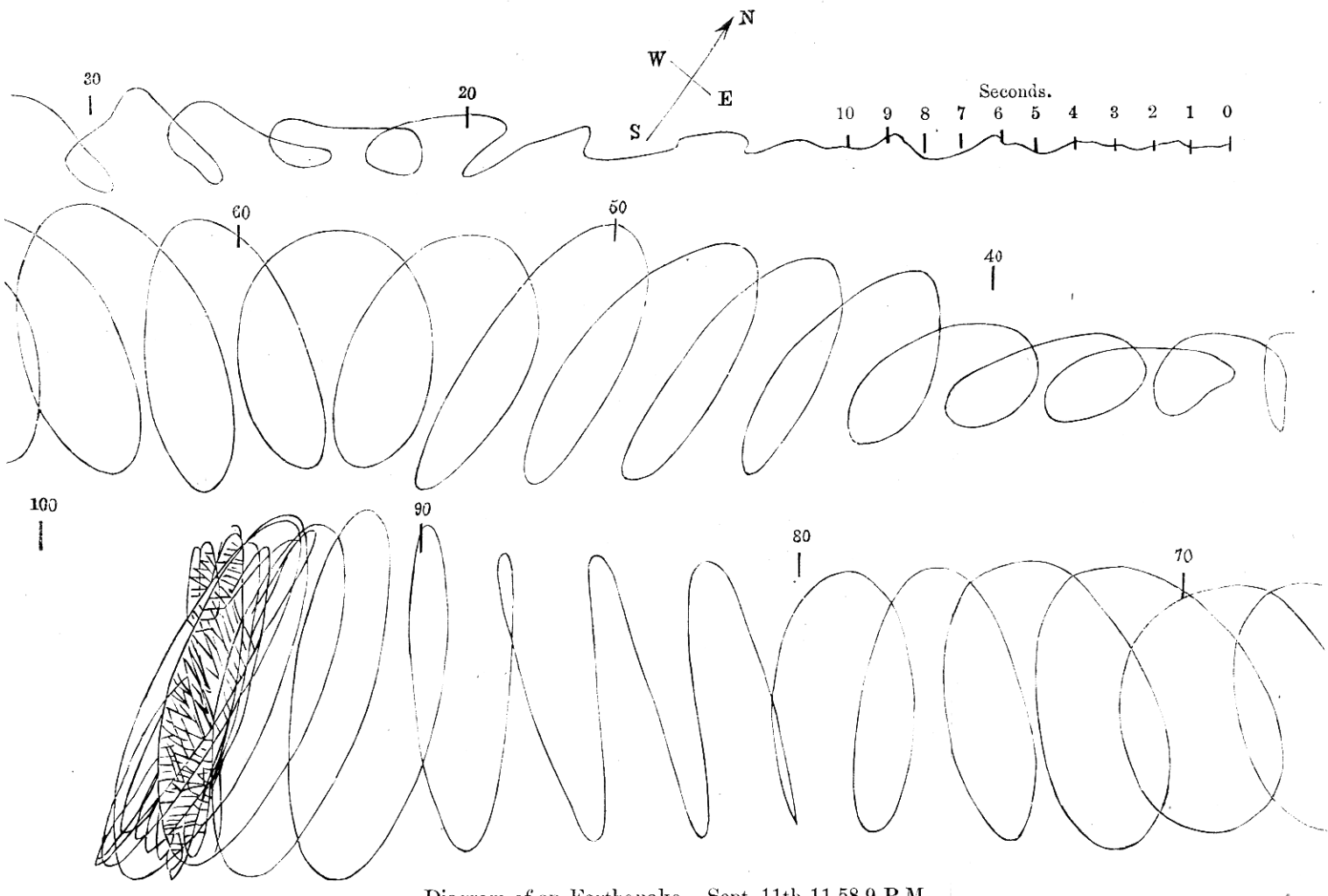

Diagram of an Earthquake. Sept. 11th 11.58.9 P.M.
CECCHI SEISMOGRAPH