N° 12,328 A.D. 1911

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PROVISIONAL SPECIFICATION.

An Improved Mechanism for Impelling Pendulums or Balance Wheels.

I, WILLIAM HAMILTON SHORTT, of "Bramcote," Bramcote Road, Putney, S.W., Civil Engineer, do hereby declare the nature of this invention to be as follows:—

This invention has reference to that type of escapement mechanism in which impulses are imparted to a pendulum or balance wheel by an impulse lever bearing with a sliding or rolling action against the face of a pallet attached to or vibrating with the pendulum or balance wheel. The direction of motion of the lever being approximately at right angles to the direction of motion of the pallet during the impulse period.

The main objects of this invention are to make the amount of the impulse received by the pendulum or balance wheel independent within certain limits of the total amount of movement of the impulse arm, and dependent on the arc of vibration in such a manner that a slight increase of the arc automatically causes a reduction in the impulse, and *vice versa*, so that the impulse exerts a decided governing action on the arc; and, when the resetting of the impulse lever is accomplished electrically, to enable a reliable electric contact to be obtained each half swing of the pendulum or balance wheel.

According to this invention the face of the pallet and the part of the lever which comes into contact with it are both shaped so that while their plane of contact is initially at right angles to the direction of motion of the lever, it tends, as the pallet moves to become parallel to the motion of the lever. The impulse lever is released when the pendulum or balance wheel is at about its mid position and comes into contact with the pallet which is immediately opposite to it, and as the pallet continues its motion the lever passes along the impulse face communicating energy to the pendulum or balance wheel. The acceleration of the lever increases with the increasing slope of the plane of contact until it becomes equal to the acceleration the lever would have were its motion unrestrained by the pallet; since the acceleration of the lever cannot increase beyond this amount, the lever and pallet part company and the impulse to the pendulum or balance wheel terminates; the lever is allowed to travel some little distance further before it comes into contact with the resetting device. The impulse received by the pendulum or balance wheel is thus independent of the total movement of the impulse lever.

If the arc of vibration increases slightly the lever and pallet part company sooner *i.e.* before the lever has travelled the normal amount, consequently the impulse is reduced in value, similarly a slight reduction in the arc enables the lever to remain in contact with the pallet for more than the normal distance with a consequent increase in the value of the impulse. The impulse therefore exerts a decided governing effect on the arc of vibration.

Should the resetting mechanism fail to act it is important that the pallet on its return swing may be able to push the lever up out of its way. The pallet and lever should therefore part company before their plane of contact makes a smaller angle than about 45° with the direction of motion of the lever. This is accomplished by loading the axis of the lever and so increasing its inertia to a suitable extent.

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The impulse always being given when the pendulum or balance wheel is swinging away from its mid position produces a slowing effect on its rate; this slowing effect increases with diminishing arc; while, in the case of the pendulum the slowing due to the circular error decreases with diminishing arc. The delayed impulse therefore enables the circular error of a pendulum to be compensated since the arc can be adjusted so that the decrease in the slowing effect due to one cause equals the increase due to the other.

The impulse lever may be reset by the usual method of stopping its descent by a platinum tipped screw or rivet attached to the armature of an electro magnet; the contact of the lever with this screw completes the circuit of the electro magnet, the armature is attracted and the lever thrown back on to its catch, a stop being provided to break the circuit by preventing the armature following the lever all the way. Since however in my form of escapement the lever is always free from the pallet when the contact is made, special means are necessary to ensure good contacts free from the slightest trace of preliminary bounce. This result is obtained by using a spring as an intermediary between the contact screw and the armature of the electro magnet and reducing the inertia of this armature to a minimum.

In order to obtain contacts each half swing of the pendulum or balance wheel, the whole mechanism, with the exception of that for resetting the lever, is designed to be symmetrical, without duplication of parts, with regard to a plane passing through the pendulum or balance wheel when in its mid position.

According to one practical form of my invention; the pallet is in the form of a small wheel mounted centrally on a pendulum near its lower end so that its axis is at a right angle to the plane of motion of the pendulum, and the impulse lever is in the form of a round steel rod; pivoted at one end about a horizontal axis parallel to the plane of motion of the pendulum, and placed so that the free end is immediately over and almost in contact with the top of the pallet wheel when the pendulum is at rest.

The lever is normally held in this position by a catch or trigger which engages with the lower extremity of an arm projecting downwards from the axis of the lever. This catch is pivoted about an axis parallel to the axis of the lever.

The lever is released by the action of a small auxiliary wheel attached to the pendulum, which each time the pendulum swings through its mid position, depresses the catch by raising its tail. An alternative method of releasing the lever is to fork the tail of the catch horizontally, and provide on an axle placed parallel to the lever two horizontally radiating arms to engage with the forked tail in such a way that a very small rotation of the axle in either direction lifts the tail and depresses the catch. This slight rotation is brought about by means of a third arm radiating vertically which is just hit by the bottom of the pendulum when swinging through its mid position in either direction.

In order to enable the amount of movement of the armature of the resetting electro-magnet to be varied without altering its normal position, the electro-magnet is mounted so as to be capable of rotation about the axis of the armature to the small extent necessary.

Dated the 19th day of May, 1911.

W. H. SHORTT.

COMPLETE SPECIFICATION.

An Improved Mechanism for Impelling Pendulums or Balance Wheels.

I, William Hamilton Shortt, of "Bramcote," Bramcote Road, Putney, S.W., Civil Engineer, do hereby declare the nature of this invention and in

what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention has reference to that type of impelling mechanism or escapement in which impulses are imparted to a pendulum or balance wheel by an impulse lever bearing with a sliding or rolling action against the face of a pallet attached to or vibrating with the pendulum or balance wheel, the direction of motion of the lever being approximately at right angles to the direction of motion of the pallet during the impulse period.

The main objects of this invention are to make the amount of the impulse received by the pendulum or balance wheel independent within certain limits of the total amount of movement of the impulse arm, and dependent on the arc of vibration in such a manner that a slight increase of the arc automatically causes a reduction in the impulse and *vice versa*, so that the impulse exerts a governing action on the arc; and, when the resetting of the impulse lever is accomplished electrically, to enable a reliable electric contact to be obtained each half swing of the pendulum or balance wheel if required.

According to this invention the face of the pallet and the part of the lever which comes in contact with it are both shaped so that while their plane of contact is initially parallel to the direction of motion of the pallet it tends as the pallet moves to become parallel to the motion of the lever. The impulse lever is released and comes into contact with the pallet at the instant when they are immediately opposite and almost in contact with one another, the pendulum or balance wheel being then near its central position. As the pallet continues its motion the lever passes along the impulse face and communicates energy to the pendulum or balance wheel. The acceleration of the lever increases with the increasing slope of the plane of contact with the pallet until it becomes equal to the acceleration the lever would have were its motion unrestrained by the pallet; since the acceleration of the lever cannot increase beyond this amount, the lever and pallet automatically part company and the impulse to the pendulum or balance wheel terminates; the lever is allowed to travel some little distance further before it comes into contact with the resetting device.

The impulse received by the pendulum or balance wheel is thus independent of the total movement of the impulse lever.

If the arc of vibration increases slightly the lever and pallet part company sooner, *i.e.* before the lever has travelled its normal amount, consequently the impulse is reduced in value, similarly a slight reduction in the arc enables the lever to remain in contact with the pallet for more than the normal distance with a consequent increase in the value of the impulse.

The impulse therefore depends on the velocity of the pallet and exerts a governing effect on the arc of vibration of the pendulum or balance wheel.

Should the resetting mechanism fail to act it is important that the pallet on its return swing may be able to push the lever out of its way. This is accomplished by loading the axis of the lever and so increasing its inertia that the pallet and lever part company before their plane of contact makes a smaller angle with the direction of motion of the lever than 45°.

The impulse lever may be reset in a variety of ways, but the most suitable is probably the well known method whereby the motion of the lever is stopped by contact with a platinum tipped screw or rivet attached to the armature of an electro magnet, which contact completing the circuit of electro magnet the armature is attracted, the lever thrown back on to its catch, and the circuit opened by the action of a stop. If this method is adopted then special means are necessary to ensure good contacts free from all trace of preliminary bounce, since with my form of escapement the lever is always free from the pallet and moving fastest when contact is made. This result is attained by using a spring as an intermediary between the contact screw and the armature of the electro magnet and reducing the inertia of this armature to a minimum. It is obvious

that the same effect will be obtained if the spring is inserted between the lever and its contact point or if both the contact points are carried by springs.

When contacts are desired each half swing of the pendulum or balance wheel, the releasing and impulsing pallets and the parts of the releasing and impulsing levers which come into contact with these pallets are so shaped and placed that they are symmetrical, without duplication, with regard to a plane passing through the pendulum or balance wheel, when in its mid position, at right angles to its plane of motion, so that the mechanism will operate each time the pendulum or balance wheel passes through its mid position.

With this symmetrical design the release takes place at zero and the impulse is delayed or given when the pendulum or balance wheel is swinging away from its mid or zero position, with a consequent slowing effect on its rate. This slowing effect increases with the diminishing arc of vibration while in the case of the pendulum the slowing due to the circular error decreases with diminishing arc. The delayed impulse therefore enables the circular error of a pendulum to be compensated since the arc can be adjusted so that the decrease in the slowing effect due to the one cause equals the increase due to the other.

In certain cases contacts may not be required every half swing of the pendulum or balance wheel, and it will be readily understood that by using an unsymmetrical release instead of the symmetrical method just described contacts can be obtained once every complete swing, also that by the further addition of a count wheel contacts can be obtained at intervals of any number of complete swings, and if such count wheel is moved forward one tooth each half swing then contacts can be obtained at intervals of any odd or even number of half swings of the pendulum or balance wheel.

According to one practical form of my invention, illustrated by Fig. 1 of the accompanying 3 sheets of drawings, the impulse pallet is in the form of a small wheel "A" mounted centrally on the lower end of the pendulum crutch "Y" and the impulse is delivered to this pallet by means of the agate pin "B¹" which projects from the side of the impulse lever "B" pivotted about the horizontal axis "C". The vertical extensions "E E" of the lever above and below the axis give it the inertia necessary to cause "A" to leave "B¹" before their plane of contact makes a smaller angle than 45° with the vertical. The lever is normally held up by the catch "D" pivotted about axis "F" and engaging with the upper end of the vertical extension "E". This catch is released each time the pallet "A" passes the pin "B¹" by the releasing roller "K" attached to the crutch "Y" depressing the tail of the catch "D" each time it passes over it.

The mechanism is adjusted so that the lever is released and pin "B¹" comes into contact with the pallet "A" at the instant when they are immediately opposite and almost in contact with one another. As the pallet continues its motion the pin "B¹" runs down the edge of the pallet wheel "A" the downward acceleration of this pin increasing with the increasing slope of the edge of the wheel until it becomes equal to the acceleration it would have were its motion unrestrained by the pallet wheel. Since its acceleration cannot increase beyond this amount the lever and pallet automatically part company and the impulse terminates.

The lever is allowed to descend a little distance further before the contact screw "L" comes into contact with the contact spring "M" attached to the armature "N" of the electro magnet "O". The time for which the circuit is closed is dependent to a certain extent on the strength of this spring but it should not be weaker than is necessary to ensure absolute certainty in the resetting action.

An alternative form is illustrated by Fig. 2 wherein the whole mechanism is placed below the bob of the pendulum. In this design the impulse pallet wheel "A" is mounted centrally on the lower end of the pendulum and the impulse lever is in the form of a round steel rod "B" pivotted at one end

about the horizontal axis "C" and placed so that the free end is immediately over and almost in contact with the top of the pallet wheel "A" when the pendulum is at rest.

The lever is normally held in this position by the catch "D" which engages with the end of the loading bar "E" mounted vertically on the axis of the lever. This catch is pivotted about the axis "F" parallel to the axis of the lever.

The lever is released by means of the trip axle "G" which carries at one end the small cross bar "H" engaging with the tails of the catch "D" in such a way that a small rotation of the axle in either direction lifts them and depresses the point of the catch. The requisite slight rotation is brought about each time the pendulum passes through its central position, by means of the releasing lever "J" which is just hit by the releasing pallet "K" attached to the bottom of the pendulum below the impulse pallet.

The loading bar "E" gives the impulse lever the inertia necessary to cause "A" & "B" to part company before their plane of contact makes a smaller angle than 45° with the vertical. After they have parted the lever is allowed to descend some little distance further before the contact arm "L" comes into contact with the contact spring "M" attached to the armature "N" of the resetting electro magnet "O".

Fig. 3 shews the modification necessary in the design of Fig. 1 to enable contacts to be obtained at intervals of 15 half swings of the pendulum. The pawls "P" & "Q" engage with the 15 tooth count wheel "R" so that the pendulum moves the count wheel forward one tooth each half swing. The vane "S" attached to the axis of the count wheel comes into contact once each revolution with the tail of catch "D", raises the point of the catch and releases the lever. Owing to the count wheel having an odd number of teeth the impulse is alternately given during right and left hand swings of the pendulum.

Fig. 4 shows an alternative design to Figs. 1 & 2 the various parts being reversed. The impulse pallet is the agate knife edge "A" mounted centrally on the lower end of the pendulum and the impulse is delivered to this pallet by means of the small wheel "B^1" which is mounted at the end of the impulse lever "B" pivotted about the horizontal axis "C" and placed so that it is immediately under and almost in contact with the pallet "A" when the pendulum is at rest. The lever is normally held by the catch "D" pivotted about the axis "F" and engaging with the projection "B^2" from the lever. This catch is released each time the pallet "A" passes the roller "B^1" by the releasing roller "K" mounted on the pendulum raising the tail of catch "D" each time it passes under it.

The loading bar "E" gives the lever the necessary inertia to cause "A" to leave "B^1" before their plane of contact makes a smaller angle than 45° with the vertical or before it coincides with the surface of the agate knife edge "A" where the angle of this knife edge is greater than 90°.

After they part company the lever is allowed to descend some little distance further before the contact spring "M" attached to the loading bar "E" comes into contact with the contact screw "L" attached to the armature "N" of the electro magnet "O".

It will be readily understood that the impulsing and releasing pallets shewn attached to the lower end of the pendulum in Figs. 2 & 4 may equally well be attached to the lower end of the pendulum crutch if preferred, without affecting the working of the escapement except in so far as the slower velocity of the end of the crutch necessitates an increase in the inertia of the lever. Also it will be readily seen that a vertical balance wheel can be substituted for the pendulum shewn in Figs. 2 and 4.

In order to enable the amount of the movement of the armature of the resetting electro-magnet to be varied without altering its normal position, the

electromagnet is mounted so as to be capable of rotation about the axis of the armature to the small extent necessary.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. An impelling mechanism for pendulums or balance wheels wherein the face of the pallet and the part of the impulse lever which comes into contact with it are both so shaped that while their plane of contact is initially parallel to the direction of motion of the pallet it tends as the pallet moves to become parallel to the motion of the lever and wherein the inertia of the lever is artificially increased by loading its axle with a balanced mass to an extent sufficient to cause it to automatically part company with the pallet before their plane of contact makes a larger angle than about 45° with the direction of motion of the pallet & so that the impulse varies with the velocity of the pallet and therefore exerts a governing effect on the arc of vibration of the pendulum or balance wheel and is independent of the total movement of the lever the travel of which while sufficiently great to ensure that it is always free from the pallet before coming into contact with the resetting device does not permit the lever to get into such a position that the pallet would be unable in the event of a failure of the resetting device to push it out of its way without injury on the return swing.

2. An impelling mechanism for pendulums or balance wheels wherein the face of the pallet and the part of the impulse lever which comes into contact with it are both so shaped that while their plane of contact is initially parallel to the direction of motion of the pallet it tends more and more as the pallet moves to become parallel to the motion of the lever the inclination of the plane of contact continuously increasing until the lever and pallet automatically part company owing to the inability of the lever to move fast enough to remain in contact with the pallet so that the impulse varies with the velocity of the pallet and therefore exerts a governing effect on the arc of vibration of the pendulum or balance wheel and is independent of the total movement of the lever the travel of which is sufficient to ensure that it is always free from the pallet before coming into contact with the resetting device.

3. An impelling mechanism for pendulums or balance wheels wherein the inertia of the impulse lever is greatly increased by balanced loading in order that it will automatically part company with the pallet at any predetermined point before coming into contact with the resetting device thus rendering the impulse independent of the total movement of the impulse lever and dependent on the velocity of the pallet so that the arc of vibration of the pendulum or balance wheel is subject to a governing influence.

4. An impelling mechanism for pendulums or balance wheels wherein the releasing pallet and the part of the releasing lever which comes into contact therewith are both so shaped and placed that they are symmetrical without duplication with regard to a plane passing through the pendulum or balance wheel when in its mid position at right angles to its plane of motion in order that release may take place and electric contact be obtained once each half swing of the pendulum or balance wheel.

5. An impelling mechanism for pendulums or balance wheels wherein a spring is introduced behind either or both of the electric contact plates in order that the security of the resetting action may not be dependent on the restraining influence of the pallet on the motion of the impulse lever.

6. An impelling mechanism for pendulums or balance wheels wherein the resetting electromagnet is mounted so as to be capable of movement about the axis of the armature in order that without altering the normal position of the armature its amount of movement may be varied.

7. The improved impelling mechanism for pendulums wherein the impulse

is dependent on the velocity of the impulse pallet and so exerts a governing effect on the arc of vibration of the pendulum, wherein the impulse is independent of the total movement of the impulse lever, wherein the compensation of the circular error is effected by a zero release and delayed impulse, and whereby reliable electric contacts may be obtained once each half vibration of the pendulum or at intervals of an odd or even number of half vibrations, substantially as described and with reference to Figs. 1 & 3 of the accompanying drawings.

8. The improved impelling mechanism for pendulums, wherein the impulse is dependent on the velocity of the impulse pallet and so exerts a governing effect on the arc of vibration of the pendulum, wherein the impulse is independent of the total movement of the impulse lever, wherein the compensation of the circular error is effected by a zero release and delayed impulse, and whereby reliable electric contacts may be obtained once each half vibration of the pendulum, substantially as described with reference to Fig. 2 of the accompanying drawings.

9. The improved impelling mechanism for pendulums, wherein the impulse is dependent on the velocity of the impulse pallet and so exerts a governing effect on the arc of vibration of the pendulum, wherein the impulse is independent of the total movement of the impulse lever, wherein the compensation of the circular error is effected by a zero release and delayed impulse, and whereby reliable electric contacts may be obtained once each half vibration of the pendulum substantially as described with reference to Fig. 4 of the accompanying drawings.

Dated this 21st day of November, 1911.

W. H. SHORTT.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1912.

A.D. 1911. May 22. № 12,328.
SHORTT'S Complete Specification.

(3 SHEETS)

SHEET 1.

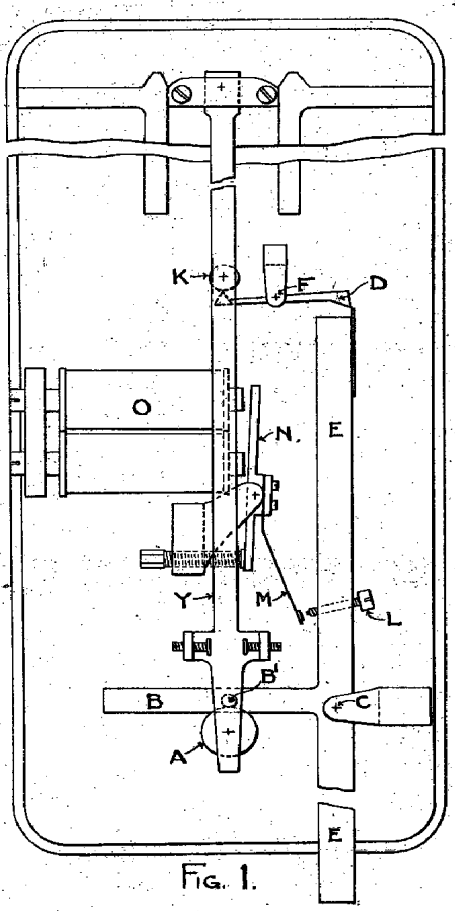

FIG. 1.

SHEET 2.

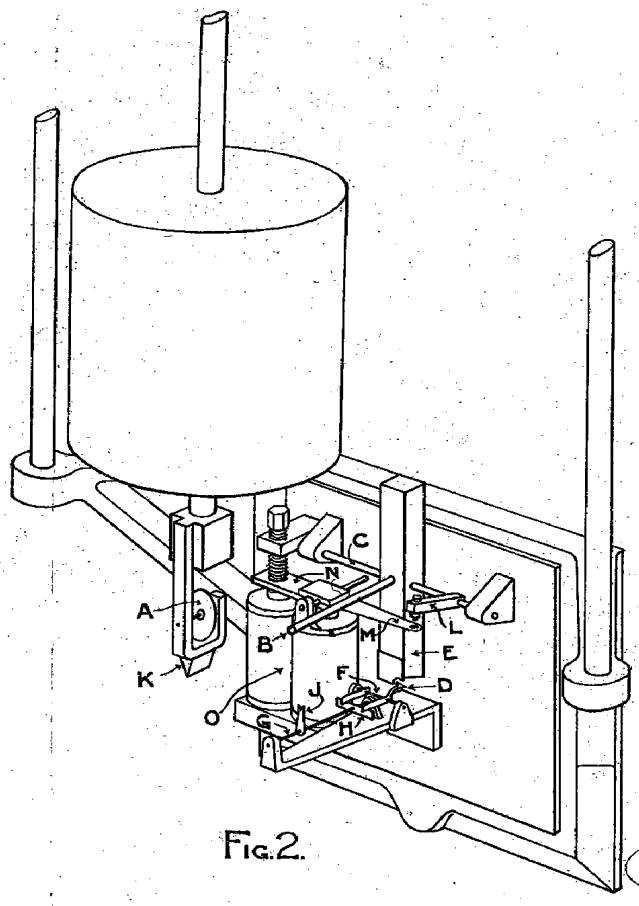

FIG. 2.

Neal by & Sons, Photo-Litho.

SHEET 1.

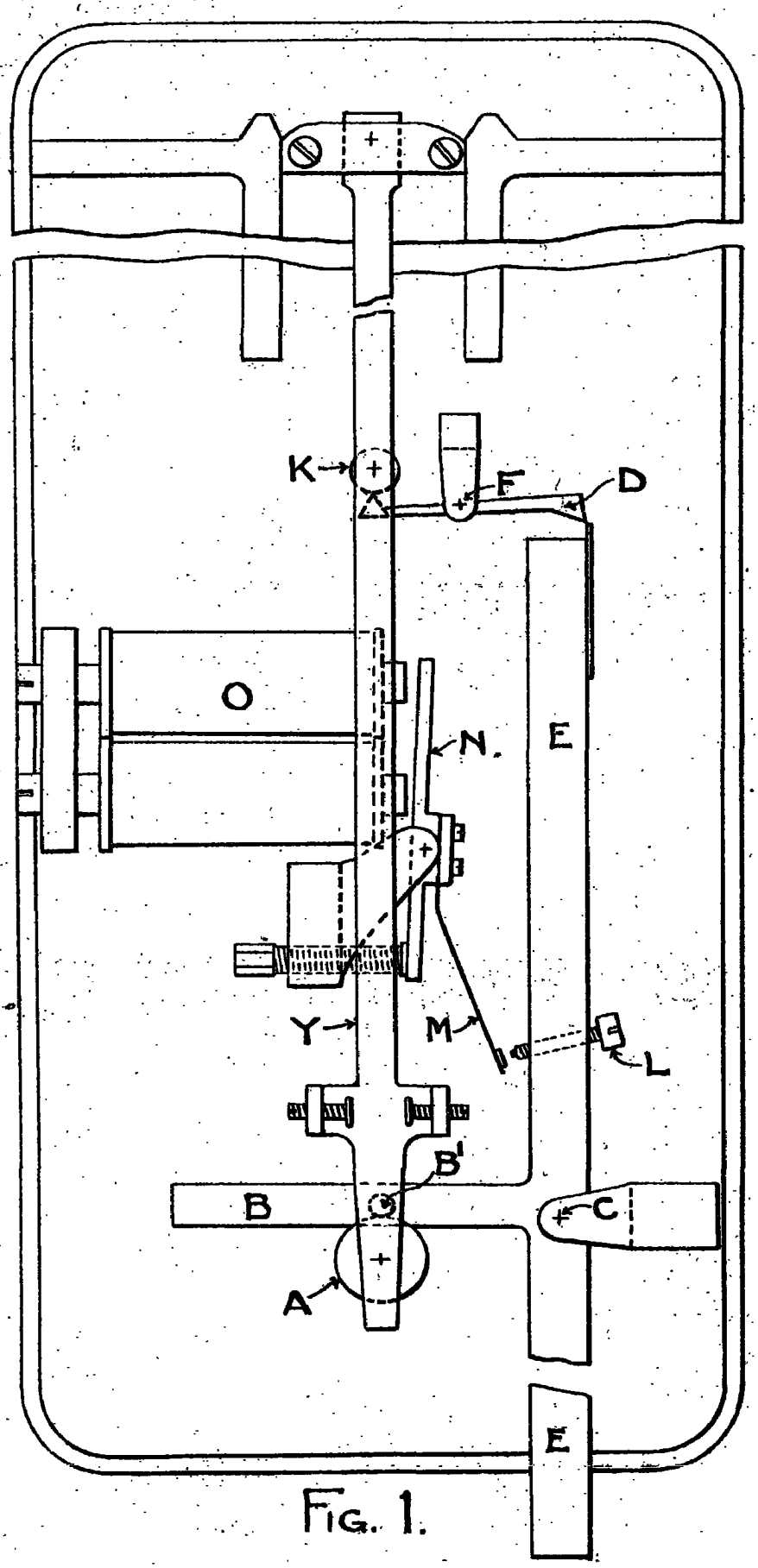

FIG. 1.

[This Drawing is a reproduction of the Original on a reduced scale]

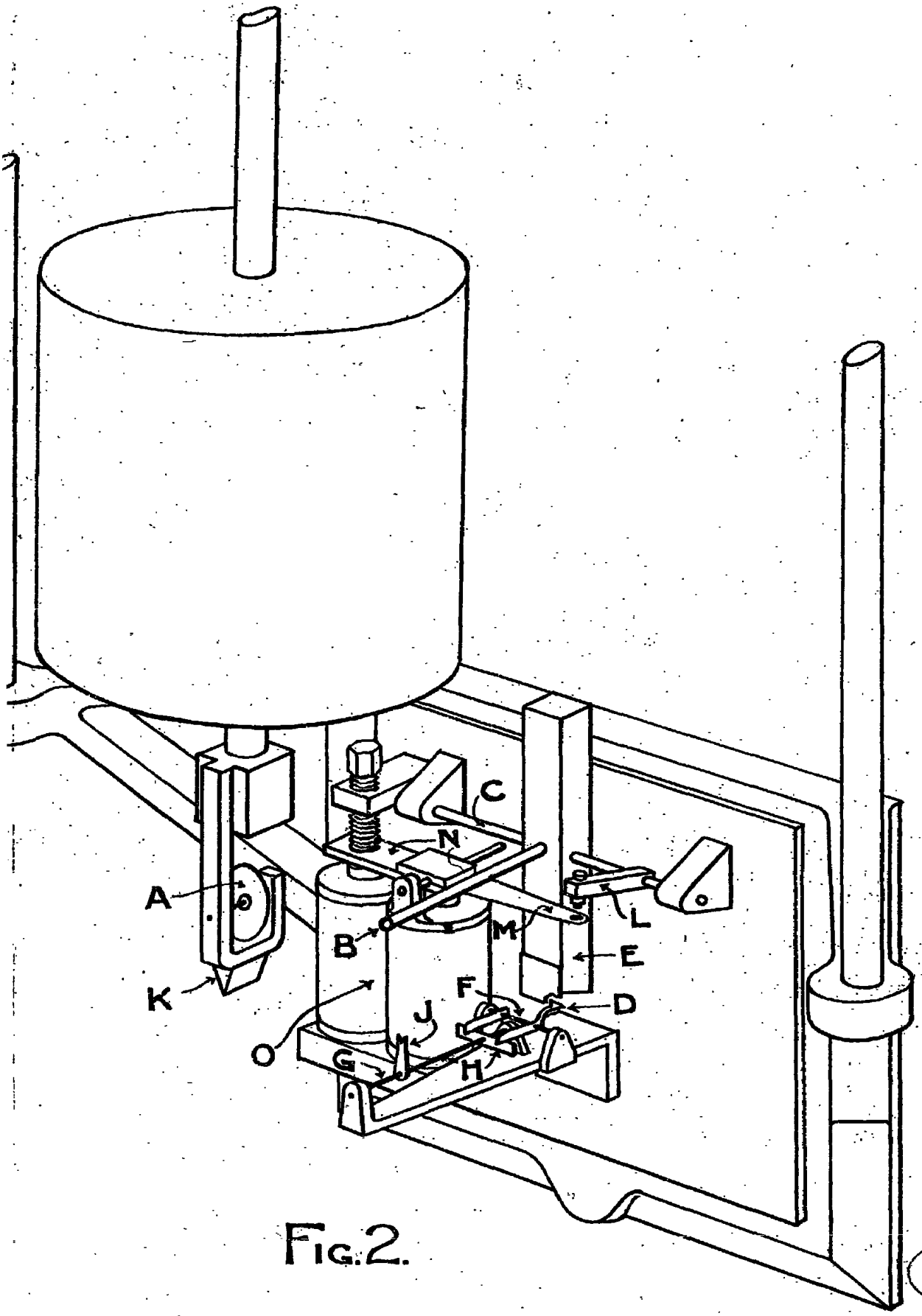

FIG. 2.

Malby&Sons, Photo-Litho.

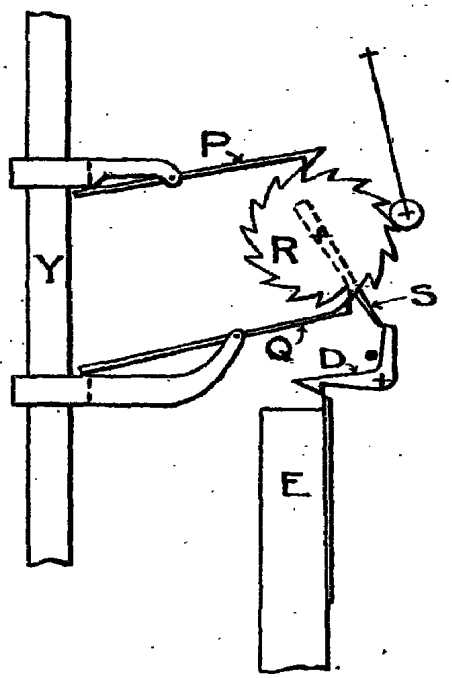

FIG. 3.

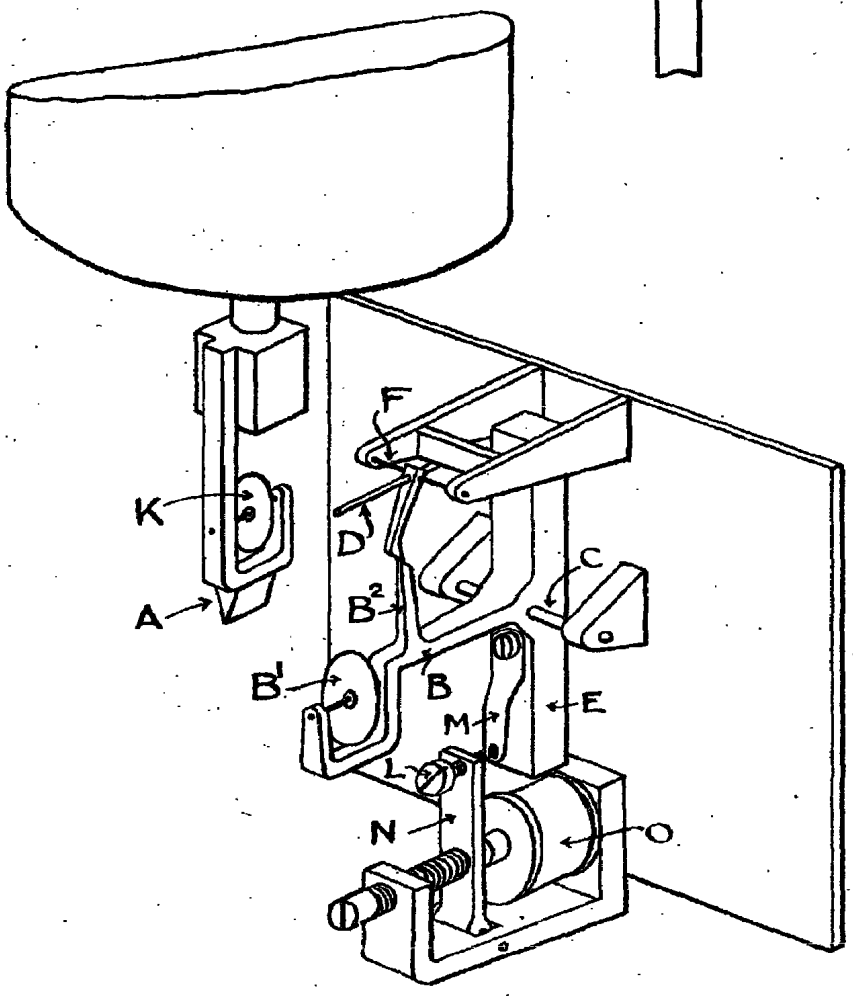

FIG. 4.

Malby & Sons, Photo-Litho.