N° 1945 A.D. 1907

Date of Application, 25th Jan., 1907

Complete Specification Left, 25th July, 1907—Accepted, 12th Dec., 1907

PROVISIONAL SPECIFICATION.

Improvements in Gravity Escapements and Electric Clocks.

We HENRY HARDINGE SAMUEL CUNYNGHAME, C.B., M.I.M.E. *etc.* of 134 Cromwell Road, London, S.W., Civil Servant and FRANK HOPE-JONES, M.I.E.E. of 32 & 34 Clerkenwell Road, London, E.C., Electrical Engineer. do hereby declare the nature of this invention to be as follows:—

This invention has for its object improvements in clocks controlled by means of pendulums, particularly electric clocks of the type set forth in Patents Nos. 1587/95, 7868/97, and 6066/05, and consists of improved means of imparting impulses to pendulums whereby greater accuracy of time-keeping is secured, yet all the advantages of the automatic timed switches therein described are retained.

According to this invention in one form of its application, a pendulum carries at its lower end exactly in the centre of its plane of motion, two small inclined surfaces of steel or other suitable metal, meeting at a point above, and sloping right and left away therefrom. One of these surfaces inclined at any suitable angle serves the purpose of an impulse pallet, and is disposed equally on each side of the centre line of the pendulum. A gravity lever lies horizontally in the path of the pendulum at this point, pivotted at the extreme right or left, and having the free end in the centre. This lever terminates in an impulse pin or roller. It is normally held up by a catch or trigger adapted to be released by a chronometer spring or its equivalent mounted upon the pendulum, and it is so adjusted that when its release takes place, the impulse pin or roller is over the sloping pallet down which it then runs thereby impelling the pendulum, the impulse being concentrated at or about its zero position, and equally on each side thereof. When it has fallen to the bottom of the inclined plane forming the impulse pallet as above described, it meets with either a catch releasing a mechanical train of key-wound clockwork capable of replacing it, or preferably the armature of an electro-magnet as described in the patents above referred to. In either case, whether mechanical or electrical the result is the same, the gravity lever being re-set by a remontoire action. The impulse of the gravity arm may be arranged to be given once every vibration of the pendulum, or once every double vibration, or at any chosen number of vibrations.

The other sloping surface in the reverse direction serves to raise the gravity lever out of the way of the pendulum in the event of either the mechanical or the electrical device having failed to raise it. It also serves as a convenient support for the chronometer spring, releasing detent, or other equivalent device. Instead of, or in addition to the force of gravity, the lever may be actuated by a spring. It may of course be moved either downwards or upwards, the inclined planes being arranged accordingly.

It will be observed that all the advantages inherent in the patents above referred to are retained, inasmuch as neither the pendulum nor the mechanism that drives it is called upon to provide any of the energy required for the purpose of making a good electrical contact.

It is of course immaterial in this invention how often the impulses are imparted to the pendulum, and the gravity lever replaced. In some instances, an impulse

[*Price* 8*d.*]

at every complete vibration of the pendulum, in others once every two seconds in the case of a seconds pendulum is desirable. On the other hand, when the operation of a large circuit of impulse dials is required, the impulse is preferably given at every fifteenth complete vibration of a seconds pendulum, namely, every thirty seconds, that being the standard periodicity for electric time service in this country. In America and on the Continent however, a periodicity of one minute will probably be adopted. Whenever this periodicity is less frequent than the time measured by one complete double vibration of the pendulum, a wheel is used with the number of its teeth dependent upon the periodicity required, and the chronometer spring, detent, or other equivalent device is adapted to move this wheel tooth by tooth, and the release is accomplished by one or more pins or other fixtures upon the wheel or its arbor.

It is sometimes desirable to still further concentrate the impulse upon the pendulum at the moment when it is passing the vertical line, and it is obvious that this may be accomplished by inclining the impulse pallet more nearly to the vertical at or about its middle portion. According to our invention it is immaterial at what speed the gravity lever descends, but inasmuch as it can only start from a position of rest by gradual acceleration determined by the laws of gravity, and inasmuch as it is sometimes desirable to slightly check its speed at the end of its stroke when it is about to make contact, we vary the shape of the impulse pallet to produce the desired results; thus it is sometimes found advantageous to give the pallet the form of a short parabola at the top which, after a steep incline, terminates as an archimedean spiral.

In another form of this our invention, the impulse is given as in a marine chronometer, the gravity lever being centred at some point coincident with the vertical line of the pendulum, and the impulse consisting of a blow delivered in line with the two centres as the gravity lever falls.

In one method of accomplishing this, a small blade is mounted upon the pendulum in a position as near to its centre of gravity as possible, and in the path of an impulse pallet carried by the gravity arm. When the gravity arm is released by the pendulum just as the latter is about to arrive at zero, it falls upon the blade and imparts an impulse to the pendulum in the form of a smart blow, the whole action taking place in the line of centres as in a marine chronometer.

Dated this Twentyfifth day of January, 1907.

HENRY HARDINGE SAMUEL CUNYNGHAME.
FRANK HOPE-JONES.

COMPLETE SPECIFICATION.

Improvements in Gravity Escapements and Electric Clocks.

We, HENRY HARDINGE SAMUEL CUNYNGHAME, C.B. of 134 Cromwell Road, London, S.W., Civil Servant, and FRANK HOPE-JONES, M.I.E.E. of 32 & 34 Clerkenwell Road, London, E.C., Electrical 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 for its object improvements in clocks controlled by means of pendulums, particularly electric clocks of the type set forth in Patents Nos. 1587/95, 7868/97, and 6066/05, and consists of improved means of imparting impulses to pendulums whereby greater accuracy of time-keeping is secured, yet all the advantages of the automatic timed switches therein described are retained.

In the accompanying drawings illustrative of our said invention and in which like letters indicate like or equivalent parts:—

Fig. 1 shows our escapement as applied to a pendulum at its lower end, the impulse being given once in every double vibration.

Fig. 2 shows a modification of the same in which the impulse is given once at every fifteen complete vibrations.

Fig. 3 shows the escapement as applied higher up the pendulum, and

Fig. 4 a modification thereof.

Referring first to Fig. 1, the pendulum *d* carries at its lower end and exactly in the centre of its plane of motion two small inclined surfaces *j* of steel or other suitable metal meeting at a point above and sloping right and left away therefrom. The right-hand sloping surface inclined at any suitable angle serves the purpose of an impulse pallet and is disposed equally on each side of the centre line of the pendulum *d*. A gravity lever *a* lies horizontally in the path of the pendulum at this point, being pivotted at *l* from whence a short vertical arm projects downwards in the same plane. This lever terminates in an impulse pin or roller *h*. It is normally supported by a catch or trigger *f* held in position by spring *s* adapted to be released by a chronometer spring *b r* or its equivalent mounted upon the pendulum *d*, and it is so adjusted that when the release takes place, the impulse pin or roller *h* is over the sloping pallet down which it then runs thereby impelling the pendulum, the impulse being concentrated at or about its zero position and equally on each side thereof. When it has fallen to the bottom of the inclined plane forming the impulse pallet as above described it meets with the contact screw fixed in the upper end of the armature *e* of an electro-magnet *g* as described in the patents above referred to. This closes the circuit of the electro-magnet *g* and a battery or other source of electric power, which circuit may or may not include indicator dials. The magnet then throws up the gravity arm *a* on to its catch *f*.

The impulse of the gravity arm *a* may be arranged to be given once every vibration of the pendulum or once every double vibration or at any chosen number of vibrations, it being immaterial in this invention how often the impulses are imparted to the pendulum and how often the gravity lever is replaced. When the operation of a large circuit of impulse dials is required, the impulse is preferably given at every fifteenth complete vibration of a seconds pendulum that is to say, once every thirty seconds, half-minute being the standard periodicity for electric time service in this country. In America and on the Continent a periodicity of one minute will probably be adopted. Whenever this periodicity is less frequent than the time measured by one complete double vibration of the pendulum, a wheel is used with the number of its teeth dependent upon the periodicity required, and the chronometer spring, detent or other equivalent device is adapted to move this wheel tooth by tooth and the release is accomplished by one or more pins or other fixtures upon the wheel or its arbor.

This may be described in reference to Fig. 2 in which the impulse is imparted every half-minute, the gravity arm *a* being approximately fifteen times as heavy as that in Fig. 1. A wheel *c* is mounted below the pendulum, and is provided with fifteen teeth and a roller back stop *u* on a balanced arm *m*. The impulse surface of the pallet *j* is on the left, and its other slope, on the right, serves to raise the gravity lever *a* out of the way of the pendulum in the event of the resetting device failing to operate. It also serves the purpose of carrying one end of a small bridge from which the chronometer detent *b* hangs vertically against the arm *r*. The trigger *f* is provided with an arm *t* adapted to engage the pin *y* in the periphery of the wheel *c*. The action of the apparatus is as follows:—

The pendulum *d* having accomplished one revolution of the wheel *c* in the space of half a minute, is now travelling from left to right. Shortly before it arrives at the zero position the chronometer detent *b r* moves the wheel *c* half

a tooth pitch and releases the gravity arm *a* through the medium of the trigger *t f*. The roller or impulse pin *h* then runs down the left-hand slope of the impulse pallet *j* thereby giving the impulse, and ultimately meeting with the armature *e* and being reset as before.

It is sometimes desirable to still further concentrate the impulse upon the pendulum at the moment when it is passing the vertical line, and it is obvious that this may be accomplished by inclining the impulse pallet more nearly to the vertical at or about its middle portion. According to our invention it is immaterial at what speed the gravity lever *a* descends, but inasmuch as it can only start from a position of rest by gradual acceleration determined by the laws of gravity, and inasmuch as it is sometimes desirable to slightly check its speed at the end of its stroke when it is about to make contact, we vary the shape of the impulse pallet to produce the desired results; thus it is sometimes found advantageous to give the pallet the form of a short parabola at the top which, after a steep incline, terminates as an archimedean spiral. Such a pallet is shown in Fig. 3 in which the gravity arm *a* and adjacent parts are located further up the pendulum, nearer to its suspension than to the bob. In this modification the click *b* is centred at *k* and is supported on the head of the screw *p*. For the sake of a symmetrical arrangement of parts the impulse surface of *j* is bracketted out to the left of the pendulum, the impulse is nevertheless imparted to the pendulum exactly at zero or equally before and after zero, the pendulum remaining perfectly free at all other times. The armature *e* is limited in its path to the right by the micrometer screw *x* with an index pointer, which ensures accuracy of adjustment.

It is of course immaterial in this our invention whether the impulse pallet *j* is fixed to the pendulum and the pin or roller *h* engaging therewith is fixed on the gravity arm or *vice versa*. In Fig. 4 the impulse pallet *j* is attached to the gravity arm *a*, and the impulse pin or roller *h* is attached to the pendulum, while the click *b* is shaped like a hook at its left-hand end thereby pulling the wheel *c* instead of pushing it. The release is accomplished by the vane *y* instead of by a pin, and in the alternative construction shown, the wheel is provided with thirty teeth, and the vane *y* is duplicated on the other side which affords a convenient means for balancing it, and facilitates the provision of a seconds hand on the arbor of wheel *c*, one which will indicate every two seconds making one revolution in a minute in a clockwise direction.

It will be observed that all the advantages inherent in the patents above referred to are retained, inasmuch as neither the pendulum nor the mechanism that drives it is called upon to provide any of the energy required for the purpose of making a good electrical contact. Then again, the automatic indication of impending failure of battery resulting from the assistance then rendered by the pendulum in the work of resetting the lever *a* is retained; also such advantages as the impossibility of stopping in closed circuit a duration of contact dependent mainly upon the combined co-efficient of self-induction of the electro-magnets in the series circuit, yet somewhat prolonged by considerable travel in company of the armature *e* and gravity lever *a* (constituting the two moving members of the switch), and also the transmission of all the energy of the system through the surfaces of the contact.

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

(1) The gravity escapement consisting of an inclined or curved impulse surface carried by a free or detached pendulum and so arranged that the pendulum when at or near the middle of its swing, releases a gravity arm carrying a pin or roller which runs down the said surface and thus impels the pendulum, combined with electrical means for replacing the gravity arm in its former position substantially as described with reference to Fig. 1.

(2) The gravity escapement consisting of an inclined plane or curved impulse surface carried by a free or detached pendulum, a gravity arm carrying a pin or roller adapted to fall thereon, a wheel driven by the pendulum and means for releasing the said gravity arm thereby just before the pendulum arrives at zero, combined with electrical means for replacing the gravity arm in its former position substantially as described with reference to Figs. 2 & 3.

(3) The gravity escapement consisting of a pin or roller carried by a free or detached pendulum and so arranged that the pendulum when at or near the middle of the swing releases a gravity arm carrying an inclined or curved impulse surface which drops upon the said pin or roller and thus impels the pendulum, combined with electrical means for replacing the gravity arm in its former position substantially as described with reference to Fig. 4.

Dated this Twentyfifth day of July, 1907.

HENRY HARDINGE SAMUEL CUNYNGHAME,
FRANK HOPE-JONES.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1907.

A.D. 1907. JAN. 25. N° 1945
CUNYNGHAME & another's COMPLETE SPECIFICATION.

[3 SHEETS]

SHEET 1

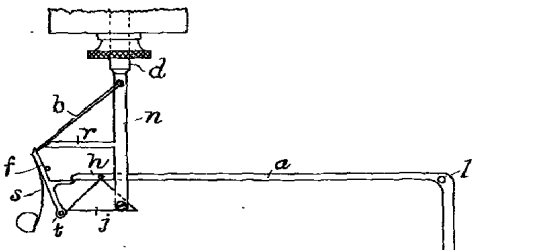


Fig. 1.

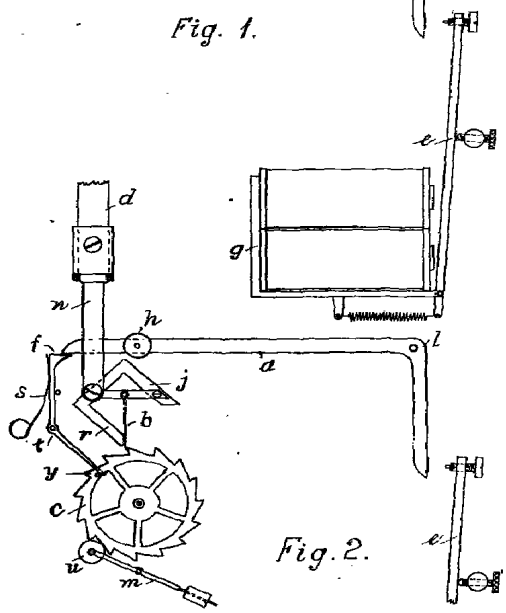


Fig. 2.

SHEET 2.

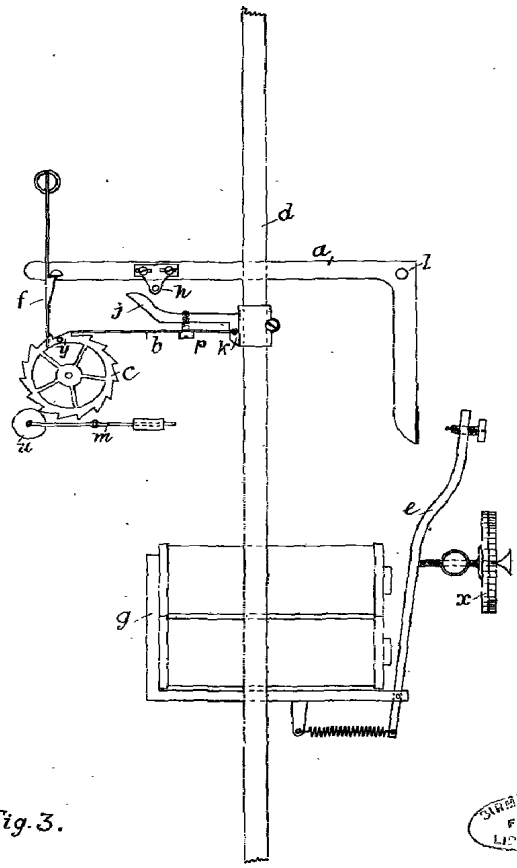
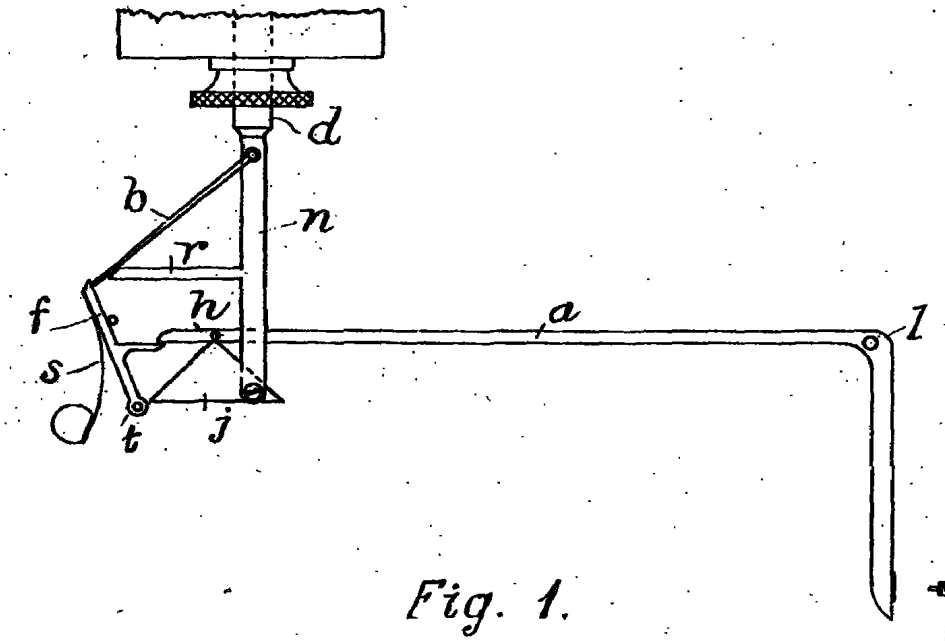


Fig. 3.

Malby & Sons Photo-Litho



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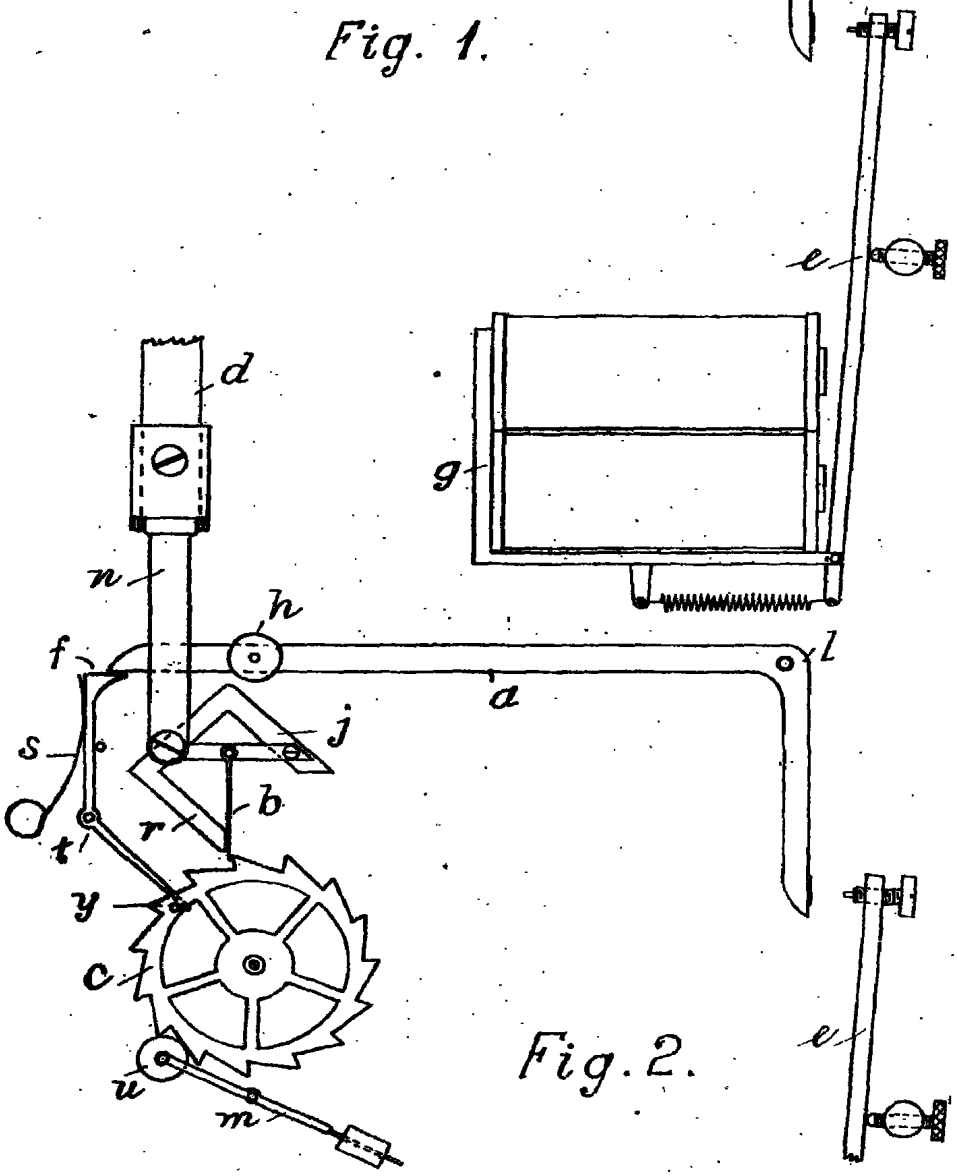

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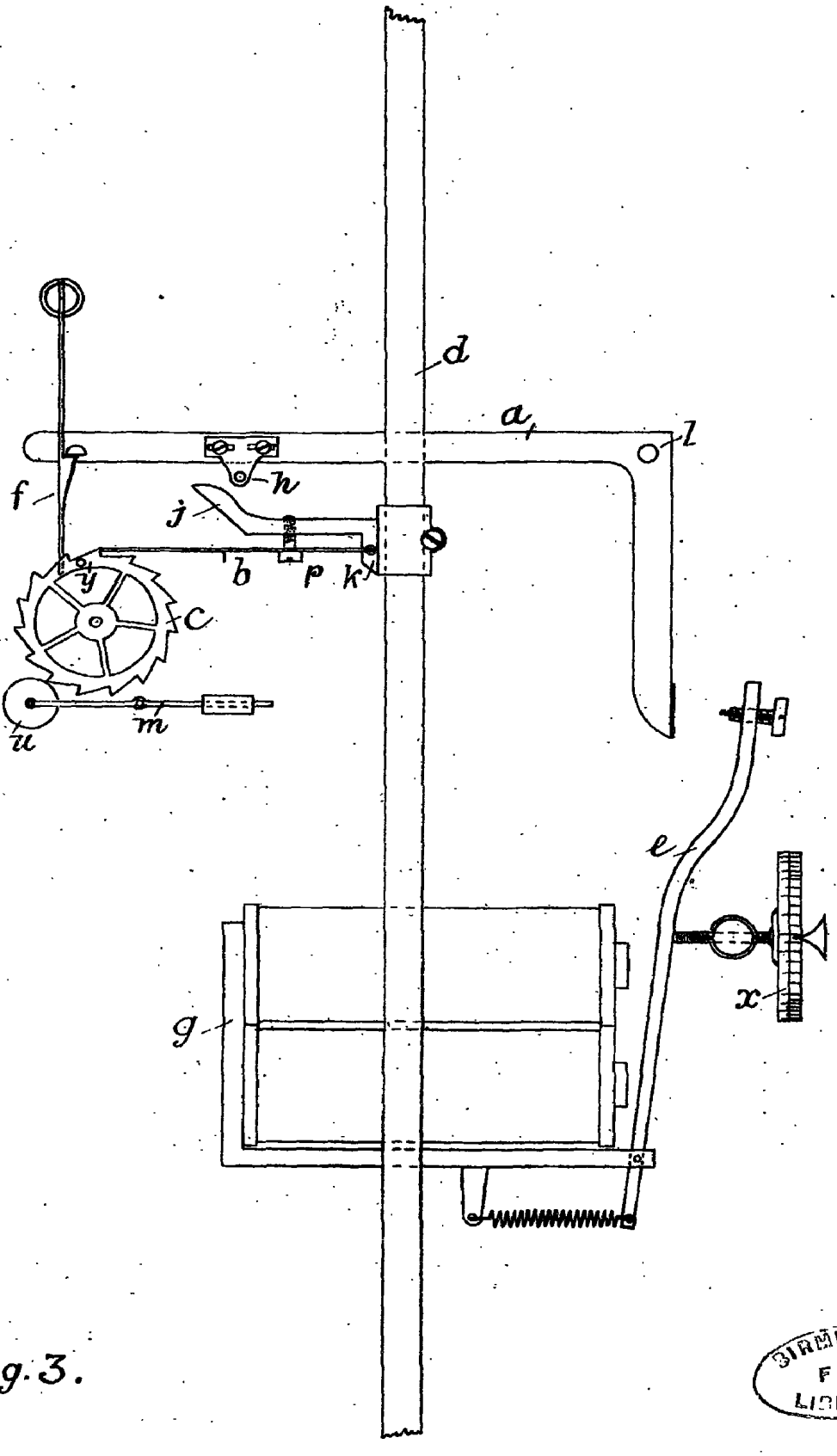

Fig. 3.

Malby&Sons, Photo-Litho.

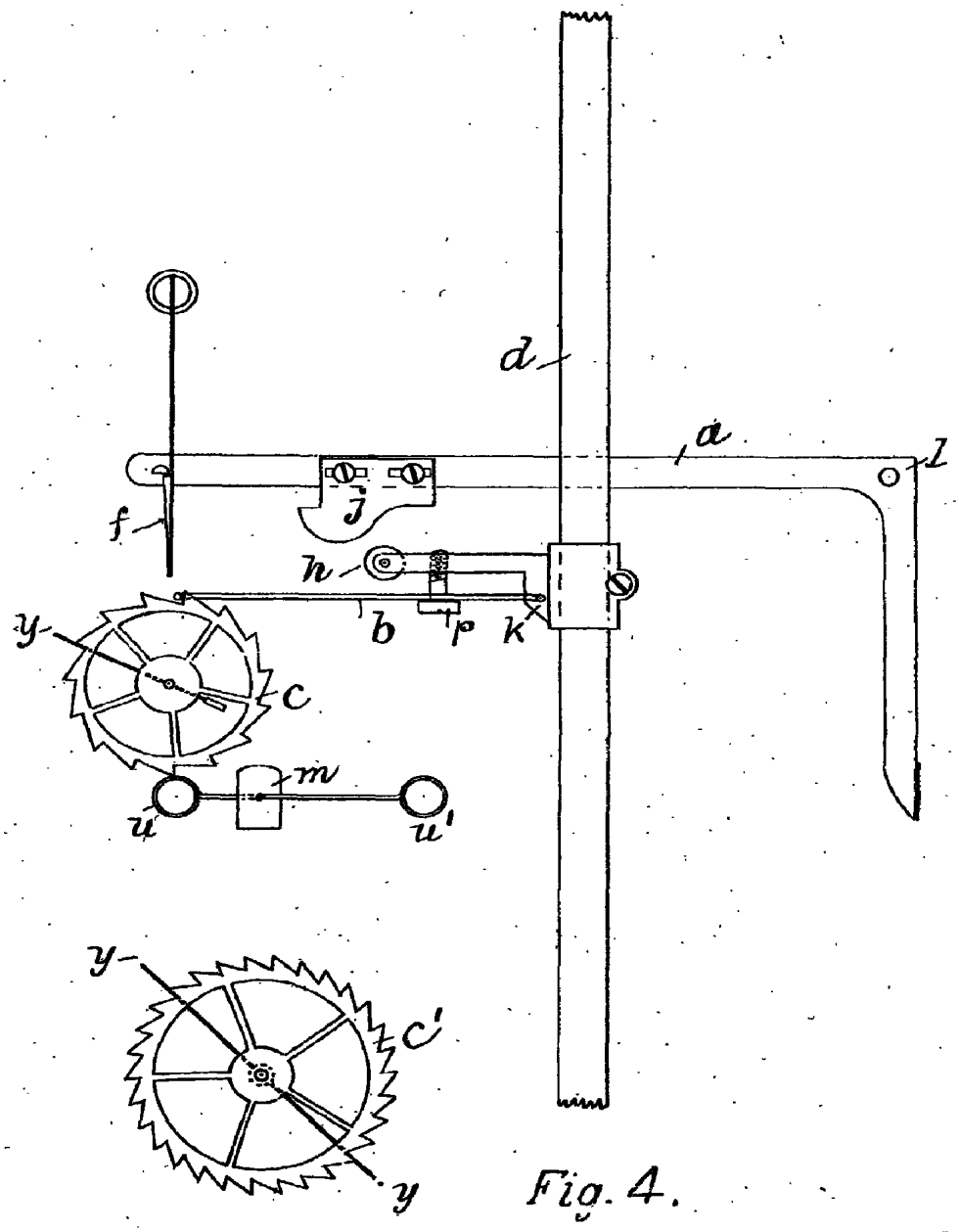

Fig. 4.

Malby&Sons, Photo-Litho.