PATENT SPECIFICATION

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Complete Left: Mar. 29, 1921.

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PROVISIONAL SPECIFICATION.

Improvements in and relating to the Synchronisation of Clocks.

We, WILLIAM SAMMONS HUBBARD, of "Byfield", Stoneygate Road, Leicester, Consulting Engineer, ISAAC HARDY PARSONS, of "The Croft", Kibworth Harcourt, near Leicester, Electrical Engineer, and ALFRED ERNEST JOSEPH BALL, of 212, East Park Road, Leicester, Clockmaker, British subjects, do hereby declare the nature of this invention to be as follows:—

This invention relates to the synchronisation of clocks by controlling their pendulums, and has for object simple and effective means for obtaining such control and synchronisation, such means not needing a mechanical or electrical connection with the wheel work of the clock to be synchronised.

In accordance with this invention, the control and synchronisation of the pendulum is effected by employing periodic half minute or minute impulses—as now commonly used for operating electrical impulse clocks and the like—for the purpose of automatically adjusting the tension of a spring or equivalent, such spring being used to influence the rate of the pendulum for the purpose of synchronisation.

In carrying this, our invention, into effect we provide a spring and a co-acting part which contact mechanically together, and we may arrange that the spring may be carried by, and consequently may vibrate with, the pendulum, in which case the spring becomes the "vibrator" and the co-acting part becomes the "stator". Inversely the spring may be fixed and become the "stator", and the co-acting part may move with the pendulum and become the "vibrator". The "stator" and "vibrator" may contact together at each vibration or each swing of the pendulum or at each periodic impulse, or, (in cases in which the pendulum vibrates an odd number per minute, as will be hereinafter described) at some of the periodic impulses.

We may so dispose the vibrator and stator that they tend to give the pendulum a gaining rate, which gaining rate is compensated for by (manually) lowering the pendulum bob sufficiently to enable the pendulum to keep time when the spring is in its centre of adjustment.

In one form we may arrange that the desired control is effected by means of a flat leaf spring which is compressed by the pendulum at every complete vibration, the contact and compression being such that the spring tends to cause the pendulum to gain when its tension is increased and to lose when the tension is decreased, provided that the pendulum be first adjusted to time at the middle adjustment of the tension of the spring.

The spring may be in contact with the pendulum during a portion of the arc of the latter, or may be in constant contact. When in constant contact, adjustment may be effected by varying the effective length of the spring, or, in a modification by varying the effective width of a fork which engages the spring at, say, each swing of the pendulum.

A convenient form of this, our invention, may, in the type in which the vibrator and stator contact for a portion of the arc at each vibration of the pendulum, be constructed as follows:—

We provide at one side of the pendulum, and fixed, say, to the frame of the clock or to the side of the clock case as part of the stator, an electro-magnet and

an armature, the latter being preferably pivotted, and disposed with its free end towards the pendulum. We send through this electro-magnet the periodical electrical impulses which may conveniently be half minute impulses as employed for the operation of electric impulse clocks. We provide as part of the vibrator, a wheel which we mount on a bracket attached to the pendulum, and so disposed that on the armature moving at periodical intervals, it, or an extension of same, contacts mechanically and momentarily with the wheel when the pendulum is at, or about the end of its swing, and so causes the wheel to turn slightly at each time of contact between vibrator and stator.

We attach to the arbor of the wheel a cam, worm, or other device, capable of progressive adjustment and reversal, and we provide a suitable connection between the cam, worm, and the lever which carries the spring, so that the latter is adjustably moved in relation to the pendulum, as will be hereinafter described.

It will be seen that if the pendulum be "slow" at the periodical movement of the armature, the wheel will be turned in one direction, while if the pendulum be "fast" it will have reached the extent of its swing, and will be returning, and therefore, the wheel will, be turned in the reverse direction. Further, if the pendulum be "correct" a slight movement of the wheel and cam will take place in both directions and the adjustments not be altered. We provide a flat leaf spring which we fix to one end of a lever, which lever we dispose approximately parallel with the length of the pendulum, and connect the opposite end of this lever pivotally to the vibrator base. At a short distance from the pivotal, connection, we attach a suitable connecting link between the lever and the cam or worm, so that the movement of the cam or worm is transmitted to the lever.

We provide, in connection with, or as the stator, a fixed adjustable stop on the frame or case of the clock which the spring engages at every vibration of the pendulum, and the arrangement is such that, on the pendulum acquiring a losing rate, the spring engages the fixed stop for a longer period, and with greater tension, due to the movement of the cam wheel, as above described, and the rate of vibration is thereby accelerated. Inversely if the pendulum acquires a gaining rate, the reverse movement of the lever causes the spring to contact with the fixed stop for a shorter period and with lessened tension, and the rate of vibration is decreased.

Instead of attaching the spring to the end of the lever and arranging that it comes into contact with a fixed stop, we may fix the spring as a stator, and arrange that the (moveable) end of the lever on the vibrator contacts with the spring at each vibration.

In another form we provide a moveable weight on the pendulum capable of being raised or lowered. We provide means whereby the cam or equivalent causes such weight to be lowered or to be raised, as the pendulum needs adjustment.

In another form we provide with its moving part a stator in the form of a rack, which we fit to the armature of the electro-magnet. We arrange that the rack moves, say, in an upward direction at each movement of the armature. We provide a vibrator in the form of a leaf spring pivotally attached to the pendulum at its upper end, and arrange that the lower end engages the rack on the rack being lifted by the armature at the periodic impulse.

We may arrange the pivotal connection with a stop on one side so that the pivot does not move when the rack contacts with the spring while the pendulum swings outwards towards the rack, but that it moves freely when the rack contacts while the pendulum swings inwards and from the rack. This pivotal connection permits the spring to run freely over the rack without effective engagement in the event of the rack lifting while the pendulum is swinging in a backward direction in relation to the rack.

In this form of our invention, the pendulum is given a losing rate, but is always accelerated by the vibrator engaging the stator at each periodic impulse. Normally the rack engages the spring when the latter has passed over half the length of the rack.

If the pendulum is "slow" at the instant of impulse, it engages the rack at a position nearby the middle of its arc, with the result that the spring is deflected to a greater extent, and the rate of the pendulum accelerated. Inversely, if the pendulum is "fast" at the instant of impulse, the rack engages the spring at a position further from the middle of its arc, and the rate of the pendulum is accelerated, to a smaller degree only, which in effect will induce a losing rate.

In another form we provide means whereby the "set" of the spring is adjustable in relation to the stop, the

adjustment being automatically changed by the pendulum to a certain position in relation to its rate, the automatic change being made at the moment of periodic impulse.

We may construct this form of the control in the following manner:—

We arrange the spring as the "stator" and the stop as the "vibrator" and we mount the fixed or non-acting end of the spring to a fitment which we pivot to any fixed base, the pivot being disposed so that the fitment may turn in the same plane as that in which the spring bends. We provide a form of clutch controlled by an electro-magnet, and arrange that the clutch normally holds the pivotted fitment rigid, together with the fixed end of the spring. The clutch may be of any known form, and may be held by friction, or may be of the definite locking or "dog" type. A convenient construction of this form of our invention may consist of a rack disposed at the end of a lever, the rack to be of approximately the same radius as the active end of the spring. The rack may be held in position by means of a suitably shaped pallet attached to the back of the armature, which pallet becomes freed from the rack on the attraction of the armature by its electro-magnet, the retraction of the armature holding the rack normally rigid.

This form of control operates as follows:—

Normally the vibrator depresses the stator at each complete vibration of the pendulum. On the armature being energised at the periodical impulse, the spring—if the pendulum is slow—moves inwards towards the pendulum until arrested by the stop on same—which forms the vibrator—and the cessation of the periodical electrical impulse allows the attracted armature to re-tract and engage the rack—the latter now being in a position which brings the spring closer to the vibrator, thereby giving greater acceleration to the pendulum. Inversely, if the pendulum is fast at the instant of periodical impulse, the pressure of the vibrator against the spring causes the said spring, together with the rack, to move further from the pendulum. The rack is then held by the retraction of the armature, and the spring being further from the pendulum, the acceleration produced by same is consequently lessened.

We apply this, our invention, to pendulums which perform an even number of beats per half minute (or other period of electric impulse), or which perform an even number of beats during a recurring multiple of half a minute (or other periodic impulse).

For instance, if a pendulum which it is desired to control performs, say, 35 beats per half minute, the control would not come into operation every half minute, but, performing as it would 70 beats per minute, the pendulum would come into position to receive control once per minute only.

In like manner, a pendulum performing $36\frac{1}{2}$ beats per half minute would come into position for control every two minutes only.

Much longer control intervals may be successfully employed provided that either the time-keeping error of the pendulum is not excessive, or that the regulating spring be of suitable strength or the regulation weight be sufficiently heavy.

We arrange the vibrator and stator with sufficient adjustment on either side of the neutral position so that, in addition to the movement required to vary the rate of the controlled pendulum, such adjustment will alter its position if the arc of the controlled pendulum increases or decreases owing to friction in the wheel train or escapement or to other causes.

Dated this 25th day of June, 1920.

WILLIAM SAMMONS HUBBARD.
J. HARDY PARSONS.
ALFRED E. J. BALL.

COMPLETE SPECIFICATION.

Improvements in and relating to the Synchronisation of Clocks.

We, WILLIAM SAMMONS HUBBARD, of "Byfield", Stoneygate Road, Leicester, Consulting Engineer, ISAAC HARDY PARSONS, of "The Croft", Kibworth Harcourt, near Leicester, Electrical Engineer, and ALFRED ERNEST JOSEPH BALL, of 212, East Park Road, Leicester, Clockmaker, all British subjects, 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 relates to the synchronisation of clocks by controlling their pendu-

lums, and has for object simple and effective means of obtaining such control and synchronisation, such means not needing a mechanical or electrical connection with the wheel work of the clock to be synchronised.

In accordance with this invention, the control and synchronisation of the pendulum is effected by employing periodic half minute or minute impulses—as now commonly used for operating electrical impulse clocks and the like—for the purpose of automatically adjusting the tension of a spring or equivalent, such spring being used to influence the rate of the pendulum for the purpose of synchronisation.

In carrying this, our invention, into effect we provide a spring and a co-acting part which contact mechanically together, and we may arrange that the spring may be carried by, and consequently may vibrate with the pendulum, in which case the spring becomes the "-vibrator" and the co-acting part becomes the "stator". Inversely the spring may be fixed and become the "stator", and the co-acting part may move with the pendulum and become the "vibrator". The "stator" and "vibrator" may contact together at each vibration or each swing of the pendulum or at each periodic impulse, or, (in cases in which the pendulum vibrates an odd number per minute, as will be hereinafter described) at some of the periodic impulses.

We may so dispose the vibrator and stator that they tend to give the pendulum a gaining rate, which gaining rate is compensated for by (manually) lowering the pendulum bob sufficiently to enable the pendulum to keep time when the spring is in its central adjustment.

In one form we may arrange that the desired control is effected by means of a flat leaf spring which is compressed by the pendulum at every complete vibration, the contact and compression being such that the spring tends to cause the pendulum to gain when its tension is increased, and to lose when the tension is decreased, provided that the pendulum be first adjusted to time at the middle adjustment of the tension of the spring.

The spring may be in contact with the pendulum during a portion of the arc of the latter, or may be in constant contact. When in constant contact, adjustment may be effected by varying the effective length of the spring, or, in a modification by varying the effective width of a fork which engages the spring at, say, each swing of the pendulum.

A convenient form of this, our invention, may, in the type in which the vibrator and stator contact for a portion of the arc at each vibration of the pendulum, be constructed as follows:—

We provide at one side of the pendulum, and fixed, say, to the frame of the clock or to the side of the clock case as part of the stator, an electro-magnet and an armature, the latter being preferably pivotted, and disposed with its free end towards the pendulum. We send through this electro-magnet the periodical electrical impulses which may conveniently be half minute impulses as employed for the operation of electric impulse clocks. We provide as part of the vibrator, a wheel which we mount on a bracket attached to the pendulum, and so disposed that on the armature moving at periodic intervals, it, or an extension of same, contacts mechanically and momentarily with the wheel when the pendulum is at, or about the end of its swing, and so causes the wheel to turn slightly at each time of contact between vibrator and stator.

We attach to the arbor of the wheel a cam, worm, or other device, capable of progressive adjustment and reversal, and we provide a suitable connection between the cam, worm, and the lever which carries the spring, so that the latter is adjustably moved in relation to the pendulum, as will be hereinafter described.

It will be seen that if the pendulum be "slow" at the periodical movement of the armature, the wheel will be turned in one direction, while if the pendulum be "fast" it will have reached the extent of its swing, and will be returning, and therefore, the wheel will, be turned in the reverse direction. Further, if the pendulum be "correct" a slight movement of the wheel and cam will take place in both directions and the adjustments not be altered. We provide a flat leaf spring which we fix to one end of a lever, which lever we dispose approximately parallel with the length of the pendulum, and connect the opposite end of this lever pivotally, to the vibrator base. At a short distance from the pivotal connection, we attach a suitable connecting link between the lever and the cam or worm, so that the movement of the cam or worm is transmitted to the lever.

We provide, in connection with, or as the stator, a fixed adjustable stop on the frame or case of the clock which the spring engages at every vibration of the pendu-

lum, and the arrangement is such that, on the pendulum acquiring a losing rate, the spring engages the fixed stop for a longer period, and with greater tension, due to the movement of the cam wheel, as above described, and the rate of vibration is thereby accelerated. Inversely if the pendulum acquires a gaining rate, the reverse movement of the lever causes the spring to contact with the fixed stop for a shorter period and with lessened tension and the rate of vibration is decreased.

Instead of attaching the spring to the end of the lever and arranging that it comes into contact with a fixed stop, we may fix the spring as a stator, and arrange that the (moveable) end of the lever on the vibrator contacts with the spring at each vibration.

In another form we provide a moveable weight on the pendulum capable of being raised or lowered. We provide means whereby the cam or equivalent causes such weight to be lowered or to be raised, as the pendulum needs adjustment.

In another form we provide with its moving part a stator in the form of a rack, which we fit to the armature of the electro-magnet. We arrange that the rack moves, say, in an upward direction at each movement of the armature. We provide a vibrator in the form of a leaf spring pivotally attached to the pendulum at its upper end, and arrange that the lower end engages the rack on the rack being lifted by the armature at the periodic impulse.

We may arrange the pivotal connection with a stop on one side so that the pivot does not move when the rack contacts with the spring while the pendulum swings outwards towards the rack, but that it moves freely when the rack contacts while the pendulum swings inwards and from the rack. This pivotal connection permits the spring to run freely over the rack without effective engagement in the event of the rack lifting while the pendulum is swinging in a backward direction in relation to the rack.

In this form of our invention, the pendulum is given a losing rate, but is always quickened by the vibrator engaging the stator at each periodic impulse. Normally the rack engages the spring when the latter has passed over half the length of the rack.

If the pendulum is "slow" at the instant of impulse, it engages the rack at a position nearby the middle of its arc, with the result that the spring is deflected to a greater extent, and the rate of the pendulum quickened. Inversely, if the pendulum is "fast" at the instant of impulse, the rack engages the spring at a position further from the middle of its arc, and the rate of the pendulum is quickened, to a smaller degree only, which in effect will induct a losing rate.

In another form we provide means whereby the "set" of the spring is adjustable in relation to the stop, the adjustment being automatically changed by the pendulum to a certain position in relation to its rate, the automatic change being made at the moment of periodic impulse.

We may construct this form of the control in the following manner:—

We arrange the spring as the "stator" and the stop as the "vibrator" and we mount the fixed or non-acting end of the spring to a fitment which we pivot to any fixed base, the pivot being disposed so that the fitment may turn in the same plane as that in which the spring bends. We provide a form of clutch controlled by an electro-magnet, and arrange that the clutch normally holds the pivotted fitment rigid, together with the fixed end of the spring. The clutch may be of any known form, and may be held by friction, or may be of the definite locking or "dog" type. A convenient construction of this form of our invention may consist of a rack disposed at the end of a lever, the rack to be of approximately the same radius as the active end of the spring. The rack may be held in position by means of a suitably shaped pallet attached to the back of the armature, which pallet becomes freed from the rack on the attraction of the armature by its electro-magnet, the retraction of the armature holding the rack normally rigid.

This form of control operates as follows:—

Normally the vibrator depresses the stator at each complete vibration of the pendulum. On the armature being energised at the periodical impulse, the spring —if the pendulum is slow—moves inwards towards the pendulum until arrested by the stop on same—which forms the vibrator—and the cessation of the periodical electrical impulse allows the attracted armature to re-tract and engage the rack the latter now being in a position which brings the spring closer to the vibrator, thereby giving greater quickening effect to the pendulum. Inversely, if the pendulum is fast at the instant of periodical impulse, the pressure of the vibrator against the spring causes the said spring, together with the rack, to move further from the pendulum. The rack is then

held by the retraction of the armature, and the spring being further from the pendulum, the quickening effect produced by same is consequently lessened.

We apply this, our invention, to pendulums which perform an even number of beats per half minute, (or other period of electric impulse), or which perform an even number of beats during a recurring multiple of half a minute (or other periodic impulse).

For instance, if a pendulum which it is desired to control performs, say, 35 beats per half minute, the control would not come into operation every half minute, but, performing as it would 70 beats per minute, the pendulum would come into position to receive control once per minute only.

In like manner, a pendulum performing $36\frac{1}{2}$ beats per half minute would come into position for control every two minutes only.

Much longer control intervals may be successfully employed provided that either the time-keeping error of the pendulum is not excessive, or that the regulating spring be of suitable strength or the regulation weight be sufficiently heavy.

We arrange the vibrator and stator with sufficient adjustment on either side of the neutral position so that, in addition to the movement required to vary the rate of the controlled pendulum, such adjustment will alter its position if the rate of the controlled pendulum increases or decreases owing to friction in the wheel train or escapement or to other causes.

Referring to the annexed drawings in which like letters indicate like or equivalent parts.

Fig. 1 shows a form of the control device with a rack as the stator and a spring as the vibrator.

Fig. 2 shows a form with a spring as a stator and a co-acting part as the vibrator, the stator spring being automatically adjusting in relation to the vibrator.

Fig. 3 shows a form which employs a spring as a stator and a co-acting part as a vibrator, the co-acting part being automatically adjustable in relation to the spring.

Fig. 4 shows a modification of the device shown in Fig. 3 in which the leaf spring is replaced by an adjustable regulating weight.

Referring to Fig. 1, the leaf spring vibrator in swinging with the pendulum swings over the stator rack C without (normally) engaging it. the armature C^1 which carries the rack C normally resting on the stop screw C^3. On, however, the armature C^1 (which is pivotted at C^2) being attracted by the electro-magnet D on the passing of the periodic impulse through the latter, the rack C is raised and the spring vibrator A on passing over it when swinging from right to left is engaged by one of its teeth and in completing its movement is deflected, thus quickening the pendulum's vibration as herein described. It is assumed that the engagement of the leaf spring has the effect of causing that swing of the pendulum to terminate sooner and the straightening out of the spring during the subsequent swing has the effect of causing this subsequent swing to be performed in less time than the normal. This action repeated at half minute or minute intervals, suffices to maintain a clock with a losing rate to time.

The spring vibrator A is pivotted to the bracket B^1 at the point A^1 and the stop B^2, prevents the spring from turning on its pivot when it (the spring) is required to be deflected. If, however, the spring A is engaged by the rack C while the pendulum in swinging from left to right, the spring runs freely over the rack without effective engagement.

Referring to Fig. 2 the leaf spring A is held in a variable position by the rack or clutch C which engages the lever A^3 which lever is pivotted to say the back of the clock case at A^1. The lever is united to the spring by means of a block A^4, which also provides the bearing for pivot A^1, and which carries the counterweight A^5. The leaf spring A is deflected by the vibrator B^3 at each vibration of the pendulum B, and the "set" or adjustment of the spring A, is varied as follows:—

In the event of the pendulum being slow at the instant of the periodic impulse, the rack C on being withdrawn from engagement with the lever A^3, (due to the armature C^1 being attracted by the electro-magnet D) the lever A^3 being free is impelled by the counterweight A^5 and carries the spring A to meet the co-acting part B^3. This co-acting part limits the movement of the lever A^3 by coming into contact with spring A, and the return of the rack locks the lever A^3 in a position nearer to the pendulum in which position it remains so long as is required by the pendulum's rate.

In the event of the pendulum being fast at the instant of the periodic impulse, the rack C on being withdrawn from engagement with the lever A^3 permits the part B^3 to raise the lever A^3 to a position

further to the left in consequence of the pressure communicated by the spring A on the part of B^3 pressing against the said spring A. The rack C then returns and locks the lever A^3 in a position farther from the pendulum in which position it remains so long as required by the pendulum's rate.

In the event of the pendulum being correct the position of the rack and lever A^3 is unchanged.

Referring to Fig. 3 the pendulum B carries the bracket B^5 which supports a wheel B^6 at one end, and a moveable contacting part or lever B^3 at the other end. The lever B^3 is pivotted at B^4 and controlled by the spring A^5 while the wheel B^6 is mounted on a pivot or stud B^{7_1}. A cam or equivalent B^7 is connected or coupled to the wheel B^6 and this cam controls the angular position of the lever B^3 through the plunger or tracker B^9 which is pivotally connected to the lever B^3 at a point B^{9a} and passes through a guiding block B^{9b}. The armature instead of being provided with a rack as in Figs. 1 & 2, is provided with an arm C furnished with a flat surface facing the edge of the wheel B^6, with which it contacts at the moment of periodic impulse. The control of the pendulum is effected as follows:—

While vibrating, the pivotted member B^3 deflects the spring A at each swing to the right, the arrangement being that with a medium deflection the gaining rate imparted by the spring is compensated for by the manual lowering of the pendulum bob the required amount so that the time of vibration be approximately correct.

In the event of the pendulum gaining, the wheel B^6 will have commenced its inward swing at the moment of the periodic impulse, and on the armature C^1 being attracted the arm C contacts momentarily with the periphery of the said wheel, turning it clockwise.

The member B^3 then recedes from the spring A in consequence of the tracker B^9 following the cam to its smaller radius at the point of contact under the influence of the spring A^5. The decreased deflection of the spring A will then cause the pendulum to vibrate more slowly.

In the event of the pendulum losing, the wheel B^6 will be approaching the end of its swing to the left at the moment of periodic impulse, and on the armature C^1 being attracted the arm C contacts momentarily with the periphery of the said wheel, turning it anti-clockwise. The member B^3 then moves nearer the spring A in consequence of the tracker B^9 being pushed out by the cam to its larger radius at the point of contact.

The increased deflection of the spring A will cause the pendulum to vibrate faster.

On the control pendulum keeping time with the master clock, the wheel B^6 remains stationary with a short periodic impulse or with a periodic impulse of appreciable duration, the wheel B^6 moves slightly in both directions, the movement in one direction cancelling the movement in the other direction.

Referring to Fig. 4 this drawing shows a device which functions as that shown in Fig. 3 except that it operates a regulating weight instead of a regulating spring. In this Fig. (4) B^7 shows a pulley or drum round which the flexible line B^9 passes preferably two or more turns with its centre turn, fixed to the drum or pulley. The line passes over jockey pulleys E, E^1, E^2, E^3, and terminates in a regulating weight A sliding on the pendulum at one end and a counterweight A^5 at the other end. The line B^3 may preferably be duplicated on both sides of the pendulum so as to give an equal support to the regulating weight.

This device operates as follows:—With the regulating weight in a middle position, the gaining rate imparted by its position above the centre of oscillation, is compensated for by the manual lowering of the pendulum bob the necessary amount to make the time of vibration of the pendulum approximately correct. In the event of the pendulum gaining, the wheel B^6 will have commenced its inward swing at the moment of periodic impulse, and on the armature C^1 being attracted the arm C contacts momentarily with the periphery of the said wheel turning it clock-wise. The drum B^7 then lowers the weight A by unwinding the line B^9 supporting the said regulating weight and the lower position of the latter causes the pendulum to vibrate more slowly. In the event of the pendulum losing, the reverse action takes place, and the regulating weight is raised by the turning of the drum, causing the pendulum to vibrate more quickly.

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. In the synchronisation of clocks by controlling their pendulums through periodic impulses from a master clock, a leaf spring deflected by the pendulum for

the purpose of acceleration beyond its normal rate of vibration, an adjusting device for automatically varying the extent of the deflection of the leaf spring and the regulation or varying of the adjusting device by the said periodic impulse in accordance with the position of the pendulum in its arc, in relation to the time of the periodic impulse.

2. In the synchronisation of clocks by controlling their pendulums through the periodic impulses from a master clock, a leaf spring deflected by the pendulum for the purpose of acceleration beyond its normal rate of vibration, an adjusting device in the form of a rack for varying the extent of the deflection of a leaf spring,—the adjusting device operated by the periodic impulses,—and the regulation or varying of the adjusting device in accordance with the position of the pendulum in its arc in relation to the time of the periodic impulse.

3. In the synchronisation of clocks by controlling their pendulums by periodic impulses from a master clock, a leaf spring which is deflected at each oscillation of the pendulum, an adjusting means such a rack or clutch whereby the leaf spring after being deflected by the pendulum a varying amount depending on the position of the pendulum at the moment of periodic impulse, is held in such position by the said rack or clutch, and the retaining of the spring in such position until at a subsequent periodic impulse the pendulum be found to have changed its rate.

4. In the synchronisation of clocks by controlling their pendulums through periodic impulses from a master clock, a leaf spring brought into operation at each oscillation of the pendulum, an adjusting means consisting of a cam or equivalent coupled with a wheel, with which wheel an armature or lever connected therewith mechanically contacts at each periodic impulse, the gradual rotation of the wheel or cam or equivalent in one direction while the clock is losing, and in the opposite direction while the clock is gaining, and a resultant alteration in the tension of the leaf spring by the movement of the said cam or movement.

5. In the synchronisation of clocks by controlling their pendulums through periodic impulses from a master clock, as adjustable regulating weight carried by the pendulum, an adjusting means consisting of a pulley, or equivalent coupled with a wheel with which wheel an armature or a lever connected therewith mechanically contacts at each periodic impulse, the gradual rotation of the wheel and pulley, or equivalent in one direction while the clock is losing, and in the opposite direction while the clock is gaining, and a resultant alteration in the position of the regulating weight on the pendulum by the movement of the said pulley, or equivalent.

6. In the synchronisation of clocks by controlling their pendulums through periodic impulses from a master clock, controlling, regulating, and adjusting devices constructed and operating as herein described and shown.

Dated this 23rd day of March, 1921.

W. S. HUBBARD.
I. HARDY PARSONS.
ALFRED E. J. BALL.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1921

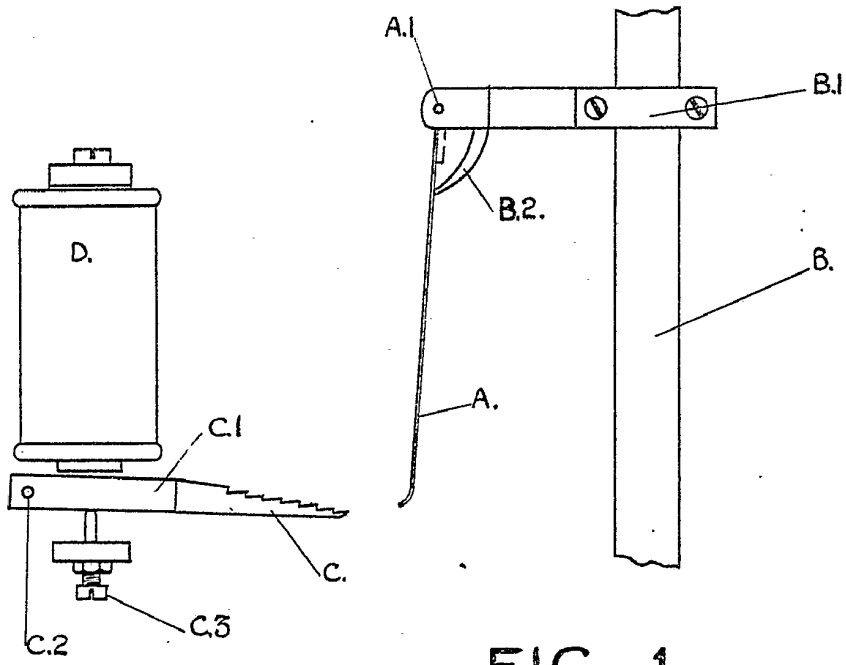


FIG. 1

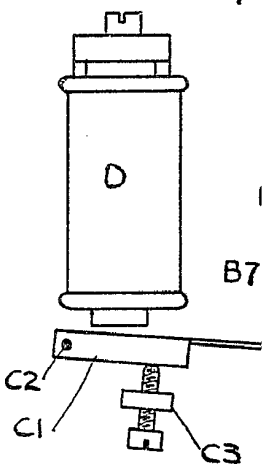


FIG. 4

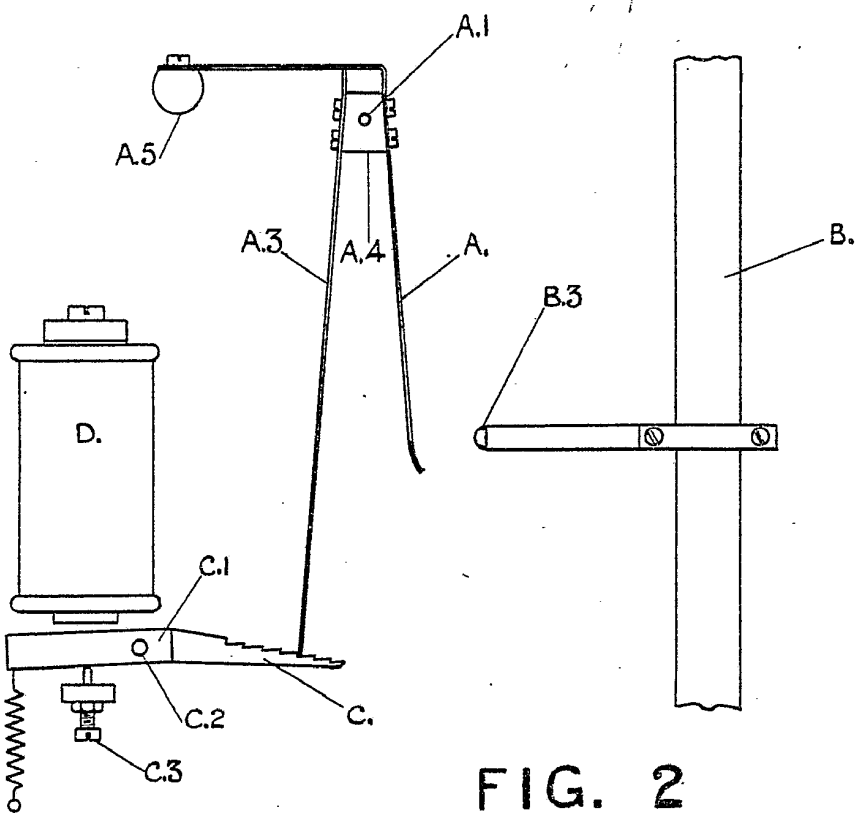


FIG. 2

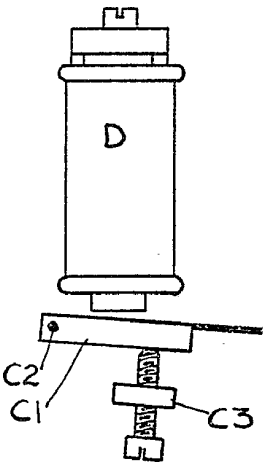


FIG. 3.

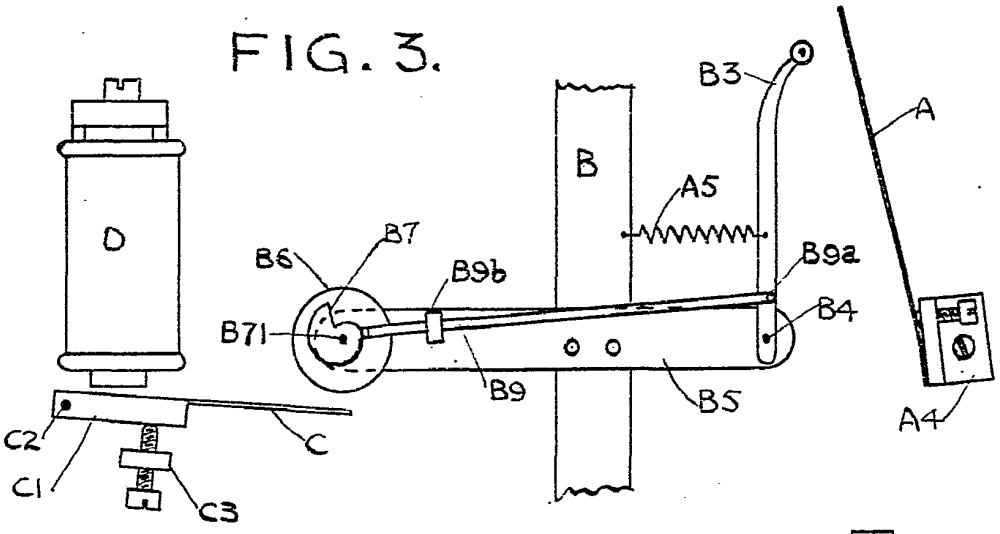
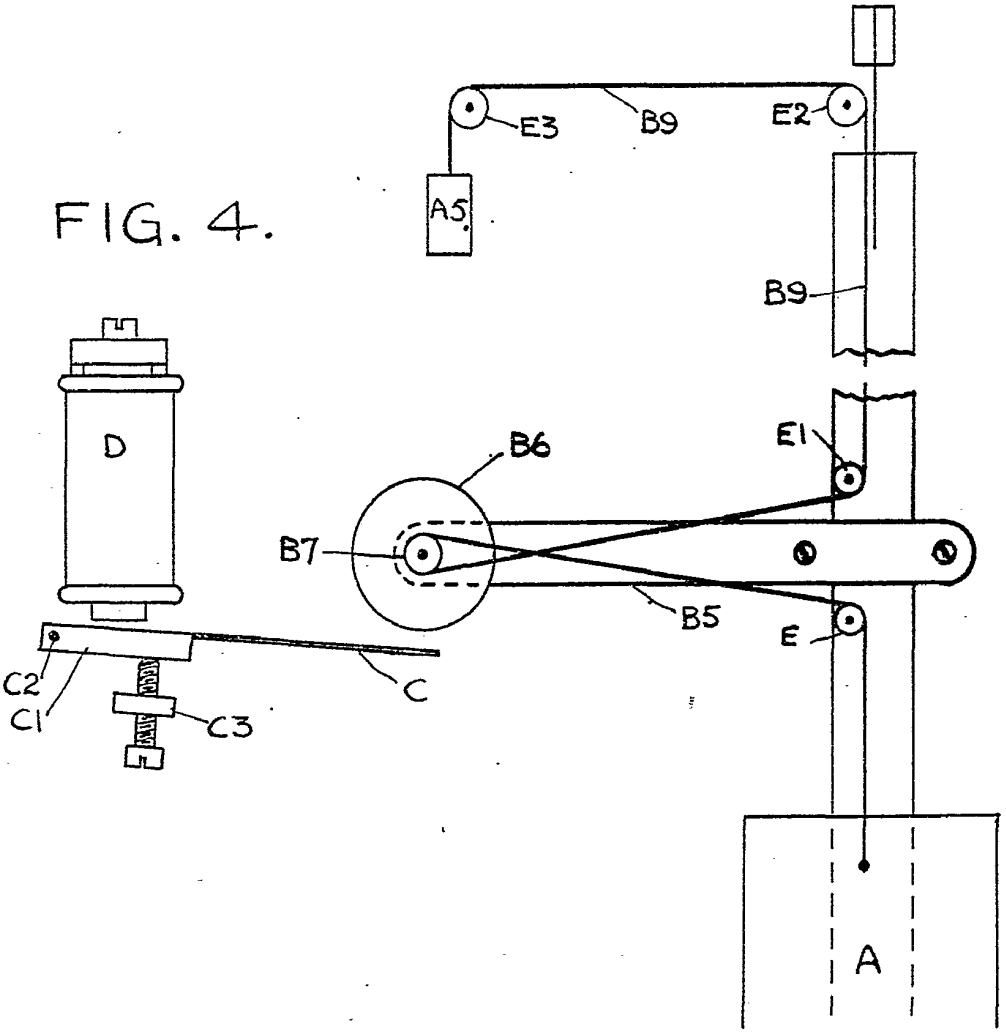


FIG. 4.



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SHEET 1

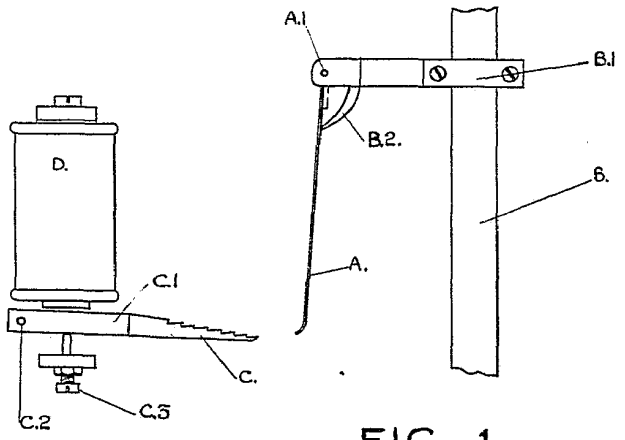


FIG. 1

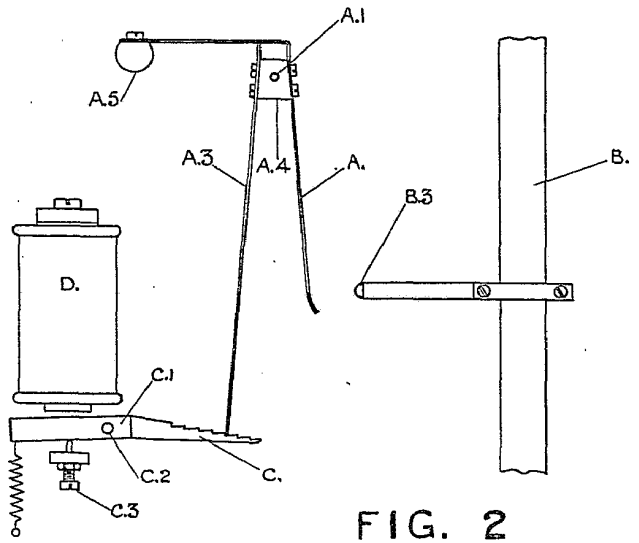


FIG. 2

SHEET 2

FIG. 3.

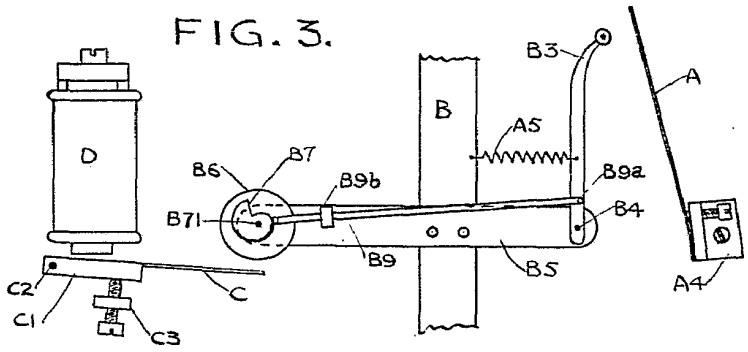
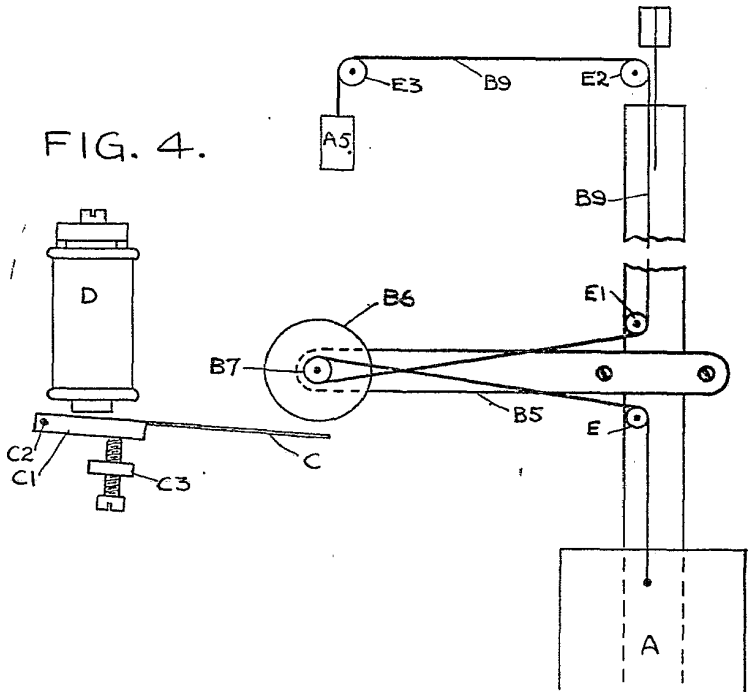


FIG. 4.



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