PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Method and Device for Setting Clocks Right from a Distance.

We, ETABLISSEMENTS LÉON HATOT, of 23, rue de la Michodière, Paris, France, a corporate body organised under the laws of the French Republic, 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:—

Our invention relates to distant control devices of the type wherein rhythmical electric impulses forming a signal are adapted to make a pendulous relay start oscillating gradually, the said relay closing the control circuit when the gradually built up amplitude has reached a predetermined value. Such devices should possess the following qualities:

a) a good selectivity which may be obtained by means of a feebly damped oscillating receiving system, the natural period of which remains exactly equal to that of the incoming signal to be received, the value of the impulses and its variations having a very small influence on this period and not being liable to put the device out of order.

b) the responsive relay should be adapted to be actuated with a very little energy so as to allow the control to be effected at great distances, for instance through radio communication methods requiring very little energy.

c) the desired control should be effected at a very precise moment in spite of the irregularities in the intensity of the signal received which may cause variations of the initial speed of the oscillating relay.

Now the object of our invention is to provide improvements in distant control devices of the above mentioned type, which improvements fulfil the above stated conditions and allow use to be made of tuned relays working with a very small damping and starting gradually under the action of a series of very small impulses which may have comparatively irregular strengths without preventing a proper working of the device.

According to our invention the relay is constituted by an isochronous beam oscillating through the action of a magnet on a copper wire coil without any iron core, the shape and arrangement of said magnet and coil being such that this action is comparatively small and substantially constant for a given current passing through the coil and throughout the oscillations of the beam, the coil being moreover fed by an impulse receiving circuit which is supplied normally with unidirectional current the intensity of which decreases when the signal impulses are received.

In a preferred embodiment the current for starting the relay pendulum is very small so as to avoid the necessity of a sensitive receiver and of amplifiers. The amplitude grows only if the periodical impulses are kept up during a long time at a period near the pendulum period whereby selectivity is simply obtained. Signals at a different frequency have no action, whereas under the action of the impulses at the proper frequency, the pendulum accumulates energy which may be used for a sudden important work such as the actuation of a switch or of parts setting the clock right.

It is preferable for the period of the pendulum to be at least 1/2 of a second. The pendulum is at least 6 cm. long so that it is possible to use large electric driving means with a good electrical efficiency requiring a small output of current. The impulses due to the signals are applied during the whole oscillation of the pendulum in one direction after which they stop. The signals are then constituted by emissions separated by silences the duration of which is equal to that of the emissions. Thus the pendulum reaches a given amplitude for a minimum current strength. With shorter emissions the strength required would be greater and the selectivity less. The reason is that if the period of the signal is one second and its duration 1/100 second the system might be started by any emission lasting 1/2 second which produces an impulse 50 times greater than each emission of the signal, that is it produces the same effect as 50 successive emissions and if the reception is stronger or fortuitous long

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emissions are produced at a frequency near that of the pendulum, the latter would start at an undesired moment.

We may use as a time signal an emission introduced in a broadcast concert, which emission may be constituted by sounds separated by silences and the frequency of which corresponds to that of the selecting relay pendulum. These sounds may be of any kind, e.g. musical notes or a sentence the syllables of which are emitted according to the desired rhythm and announce the signal. This may be provided by a phonograph synchronised by a clock.

The setting right may be controlled by an ordinary wireless receiver. For each sound signal an alternating current at audio frequency is emitted. After amplification if desired, the pendulum will start gradually and finally close a switch over an electromagnet acting on the hands through a cam or otherwise. Details of such and similar devices are described hereinafter.

The selecting pendulum may be started as follows:

The pendulum carries a permanent magnet passing through a hollow coil acting on the pendulum as in usual electromagnetic clocks with a driving pendulum.

In this case, alternating current would have no action and rectification is necessary or one of the polarities should be suppressed, for instance by a detecting and amplifying vacuum tube. The undulating current is then fed to the coil. Of course, the known connections used in radio communication and telemechanical devices may be employed. The current actuating the selecting pendulum may be an undulating or continuous current periodically damped by the elementary signals.

The use of an air cored coil, attracting a magnet secured to the pendulum is of advantage because much weaker current is necessary than when it is necessary to magnetize soft iron.

The current can be further decreased by using a pendulum oscillating in a vacuum and provided with one or more powerful magnets and large coils so as to reduce the mechanical and electric losses as is known in the art for electromagnetic clocks.

The pendulum period being adjusted so as to be near that of the signals, a heavy pendulum may be actuated by a very weak electric power comparable to that required by telephones. The commercial interest of our invention is considerable as it allows the setting right of clocks to be effected by means of very simple receivers without amplifiers. The working is very reliable as the work which the relay pendulums can give out suddenly after storing energy gradually is considerable.

In all the above described systems the selecting pendulum does not start at once. The start is more or less slow according to the quality of the telephonic or telegraphic reception. After the signals have ceased, the oscillations continue for a time depending on the amplitude of the oscillations at the end of the signals.

The accuracy may nevertheless be made very great by making the pendulum reach an amplitude which is always the same at the interruption of the signals. At each emission which makes the pendulum start and stop after a variable number of oscillations, a predetermined movement of a controlling part is obtained and its return to its original position. For instance, two series of emissions at different periods may be used. At the receiver two pendulums are tuned to the two periods respectively, and are actuated by the two parts of the signal. One of the pendulums may make a ratchet wheel or the like rotate, which ratchet wheel is brought back to its starting position by the other pendulum as will be described hereinafter.

Our invention may be used with radio communication methods along telephonic wires or electric mains of any kind without troubling the normal work thereof.

Our invention may further be used for other applications, chiefly for telemechanical devices where the control need not be very rapid. For instance, it may be used for controlling a switch for public lights, for effecting the modification required when the tariff applied in a meter is to be changed, say every evening and morning, and for the control of electric substations and the like.

The selecting pendulum may work with intermittent current or continuous slightly undulating current. In the latter case we use, in addition to the coil fed with undulating current, a coil fed with D.C. and acting in a contrary direction to the former so that the total action on the pendulum is equal to the action of a coil fed with A.C., the intensity of which is equal to the difference between the undulating current and its mean value. Thus the setting right in time distribution systems may be provided by using a series of small periodical variations of the current distributed by electric mains. This variation of the voltage constituting the signal may be obtained at the central station by acting on the voltage regulator through a relay controlled by a pendulum. If the voltage is modified by less than ·2% the satisfactory working of the pieces of apparatus fed by the mains is not disturbed as such variations occur normally in electric mains.

We have described hereinafter with reference to the appended drawings a form of construction of a clock adapted to be set right by wireless waves according to our invention. The casing of this clock may contain the pendulum relay and the parts necessary for amplifying the signals and setting the hands right. It is sufficient to connect it with an ordinary broadcasting receiver. All the parts are very simple and cheap.

Fig. 1 is a general diagrammatic view.

Fig. 2 shows an electromagnetic clock wherein an electromagnet sets the minute hand right when the clock is a few minutes fast or slow.

Fig. 3 is a cross section of the clockwork.

Fig. 4 shows at an enlarged scale a heart-shaped cam and its control.

Fig. 5 shows diagrammatically a modified form of the switch controlled by the pendular selecting relay.

Fig. 6 shows diagrammatically a device wherein the pendular relay makes the cam rotate by one revolution for each signal.

Figs. 7 and 8 are detail views of the same device.

Fig. 9 shows diagrammatically a receiving station with two pendulums actuated in succession so as to make a ratchet wheel rotate exactly by one revolution.

Fig. 10 shows diagrammatically a distant control arrangement connected to energy distributing mains.

Fig. 1 shows at 1 a wireless receiver of a usual type. The terminals usually connected with a telephone receiver T are shown at 2 and 3. The pendulum which is to be set right automatically may be of any desired type. On fig. 1 the spindle 4 of one of the hands is shown alone. This hand is secured to a sleeve frictionally driven by the spindle 4 and is rigidly secured to a heart shaped cam 5. This cam may be actuated by a tooth 6 borne by the armature 7 of an electromagnet the coil of which is shown at 8. Each time the electromagnet 8 is excited the tooth 6 adjusts the cam so that it settles in the bottom of the cam notch and sets the hand back into a predetermined position corresponding to the minimum radius of the heart shaped cam 5.

The receiver comprises generally two batteries adapted to heat the filaments of the three electrode valves of the receiver and to feed the anode circuit. The connections of these batteries 9 and 10 with the receiver 1 are not shown, for sake of clearness.

The electromagnet 8 is connected in a circuit comprising in series the battery 9 and a switch formed by a spring 11 and the rod 12 of a small pendulum forming the selecting pendular relay. This pendulum is provided at its lower end with a magnet 13 one end of which is inside the hollow coil 14; the natural period of the pendulum 13 is chosen very near that of the time signal given out every day by the wireless emitting station.

The terminals 2 and 3 of the receiver are connected with the coil 14 through a switch 15 and detecting means adapted to cut off one half of the pulsations of the undulating current from the receiver so that the coil is only fed with current of a given polarity, which current excites the electromagnet in such a manner that it attracts the magnet 13.

The diagram in Fig. 1 shows by way of example a vacuum tube connected as a detector. The connections comprise a transformer 16, a condenser 17 connected to the grid 19 of the tube and a resistance 18 connected across the condenser; the filament 20 of the tube is connected with the 4 volt heating battery 9 and the coil 14 is inserted in a circuit comprising the 80 volt battery 10 and the anode 21 of the tube.

This arrangement is set up and adjusted in the manner well known in itself so that when an alternating voltage at audio frequency is produced between the terminals 2 and 3, the plate current is caused to pass through the coil 14.

The spring 11 is suitably held away from the rod 12 so that the electric contact 11—12 is made only when the amplitude of the oscillations of the pendulum 12 is sufficiently great.

The operation is as follows:

When a non-periodic signal is given out by the emitting station, the coil 14 is fed with a very weak undulating current which cannot set the pendulum 12 going. On the contrary, during the time signal, the coil 14 receives a current the strength of which varies periodically according to a curve corresponding to the natural period of the pendulum which starts moving and ultimately comes against the spring 11 at the left end of its periodical swing.

When the contact 11—12 closes, the electromagnet 8 attracts its armature 7 and the tooth 6 acts on the cam so as to bring the hands back into a predetermined position. When the time signal stops, no more impulses are given to the pendulum 12 which is damped. As soon as the contact 11—12 is no more closed, the armature 7 is no longer actuated and no longer comes into contact with the cam 5, so that the hand continues to move freely under the action of the clockwork. The time which elapses between the stopping of the time signal and the moment when the electromagnet ceases being excited can be ascertained and the hand suitably shifted with reference to the cam 5 so as to take into account the time thus elapsed and move the hand into a position indicating approximately the right time.

Means may be provided for giving the pendulum 12 an amplitude which is always the same at the end of the time signals, whatever the irregularities in the reception may be.

For this purpose we use a pendulum 12, the natural period of which for small amplitudes is slightly greater than the period of the time signals. A stop 22 is disposed near the rod so that, a little before the end of the signal, the pendulum reaches the amplitude for which it comes against this stop. The arrangement of the receiver is such that this amplitude is reached in all cases, even with a poor reception. Experience shows that towards the end of the signals, the amplitude of the pendulum remains substantially constant and strikes the stop lightly.

Therefore at the end of the daily time signals the oscillations of the pendulum have always the same amplitude corresponding to the position of the stop, in spite of the irregularities in the reception. Therefore it is sufficient for the time signal of the emitting station to end always at a predetermined time. The pendulum 12 then continues to oscillate so as to close the contact 11—12 and cause the tooth 6 to come against the cam 5, during a period which is always the same as it depends solely on the damping conditions of the pendulum. It can thus be taken into account for setting the hand with reference to the cam 5 and the result is thus obtained that when the pendulum ceases to establish the contact 11—12, the hand gives the right time.

Figs. 2 and 3 show by way of example a preferred construction of the device as applied to an electric clock of the type described in our prior patent 222,432.

This clock comprises a pendulum 23 carrying a magnet 24 and receiving a periodical impulse from a coil 25 through a contact not shown. The pendulum moreover actuates gearing controlling the hands and shown on Fig. 3. The wheels are mounted between the plates 26 and 27. The movement of the ratchet wheel 28 is transmitted through reduction gears to the wheel 29 which is frictionally mounted on the spindle 30 of the minute hand 31¹. A spring provides a small amount of friction between the spindle 30 and the wheel 29 whereby the spindle is driven by the latter; but a very small effort makes the spindle rotate in the wheel. The end of the spindle is frictionally wedged in the socket 31 rigidly secured to the minute hand 31¹ and controlling the hour hand 31¹¹ through the usual gearing. The socket 31 is secured on a notched disc 32 (Fig. 4) performing the function of the cam 5 of Fig. 1. The disc is under the influence of the pin 33 borne by the bent lever 34 (Fig. 2). This lever is pivotally secured to the spindle 35. The armature 36 of a small electromagnet 37 is disposed so as to act on the small arm of lever 34 which is caused to rotate in the direction of the arrow *f*. It is easy to see that this is sufficient to bring the minute hand back into the proper position if it is fast or slow by less than 5 minutes. This form of construction is of great interest because a very small effort is sufficient for moving the hand and the electromagnet may be fed with current of small strength as the movement of the armature is multiplied through the lever 34 and the air gap of the electromagnet may be very small.

The contact 11—12 Fig. 1 may be replaced by the contact shown on Fig. 5 of a type known in itself. The pendulum 12 is provided with a pawl 38 which actuates the ratchet wheel 39 when the oscillations have a sufficient amplitude. The electric contact 11—12 is provided between a spring contact 12 and a detent 11. This allows a very sudden closing and breaking of the first contact part and sufficient pressure of contact due to the fact that the ratchet wheel is rotated with all the potential energy of the pendulum to which it has been gradually imparted through the impulses given to it for starting.

Instead of acting on the cam through an electromagnet 8, the pendulum may act directly on the cam without any electric contact device. Figs. 6 and 7 show an arrangement devised to this purpose.

The relay pendulum 12 (Fig. 6) when it starts oscillating makes the ratchet wheel 40 rotate, which wheel is rigidly secured to the cam 41 adapted to raise and let fall a lever 42 (Fig. 7) acting on the heart shaped cam 5 of the hand to be set right.

In order to obtain an accurate working, it is necessary for the ratchet wheel 40 to rotate exactly by one revolution when the time signal is given out. Now it is impossible to make the number of oscillations of the pendulum always correspond exactly to one complete revolution of the wheel 40; in order to solve this problem we use a ratchet wheel of the type shown in Fig. 6, which has a blank 40^1 in the place of one tooth gap whereby for a given position of the wheel, the latter can no more be actuated, the end of the pawl 43 not finding any further grip on the wheel teeth. The catch or detent 44 is pivotally secured at 45 to the end of the movable lever 46 pivoting round the spindle 47. A knife shaped part 48 pivots freely round a point of lever 46. On the rod of the pendulum 12 is secured a part 49 provided with a narrow slot parallel to the edge of the knife 48.

The operation is as follows: at the beginning of the time signals, the ratchet wheel is at least one tooth further in the anticlockwise direction than is shown in Fig. 6. Therefore when the pendulum oscillates sufficiently it makes the ratchet wheel move tooth by tooth until the closed tooth gap 40^1 appears in front of the pawl 43. The wheel 40 is then no longer actuated. It should be noted that when the amplitude of the pendulum 12 is great, the part 49 passes freely under the knife 48 which it pushes away from its path.

When the time signal is at an end, the pendulum is damped and a moment comes where the return oscillation occurs exactly at the moment when the edge of the knife 48 is in the slot in the part 49. The knife is thus wedged therein (Fig. 8) and the arm 46 rises and falls and thereby makes the ratchet wheel advance by the value of one tooth interval. But this rotation is discontinued since the pendulum 12 stops very soon after. The ratchet wheel is then adapted to be actuated again at the next time signal. The manner of working of the parts 48 and 49 is similar to that of the current closing device used on the old clocks of the well known Hipp type, which device works in a most satisfactory manner.

Instead of the above described arrangement comprising the lever 46, any other suitable arrangement may be used for setting the ratchet wheel in the desired position after the end of the time signal. For instance the clockwork may act on a cam controlling an arm which makes the ratchet wheel move by one tooth a little before the time signals whereby the ratchet wheel is brought into a position where the pawl 43 may move it.

We may use an auxiliary pendulum 12*a* (Fig. 9) having a length different from that of pendulum 12 and controlled by a special signal emitted at a frequency corresponding to its natural frequency.

The coils for keeping up the oscillations of the pendulum 12 and 12*a* are inserted in the receiving circuit and the said pendulums start oscillating according to the frequency of the signal received.

An arrangement shown on Fig. 9 makes the ratchet wheel 40 advance at each signal by a given angle, this wheel being under the action of two pawls borne by the rods of the two pendulums respectively.

The signal should in this case comprise two parts in succession at the frequency of the pendulum 12 and 12*a* respectively.

The above described devices may be used for other purposes than setting clocks right, in all cases where a distant control need not be instantaneous. It may be adapted to wired and to wireless telegraphy and telephony. It may be used for a distributing system of electrical energy wherein a single masterclock controls the change over from one tariff to another in subscribers' meters, the lighting and extinguishing of public lights, the switching on and off of local or subscribers' transformers or of heating appliances and so on.

As known in the art the receivers may be connected with the central station through one wire of the mains and so-called control wires, these wires being fed by current impulses through the masterclock with a view to exciting the receiver electromagnets as shown in Fig. 10, 50 being a wire of the mains and 51 the pilot wire. The switch is shown at 52 and the A.C. or D.C. electric supply at 53.

A receiver comprises for instance, a pendulum 12 having a natural period T and the pendulum 12*a* having a natural period T^1, both acting on a ratchet wheel as on Fig. 9. The pendulums are provided with two coils 54 and 53 which attract the soft iron cores carried by the end of the pendulum and are connected with the wires 50—51 through condenser 56 if required by the voltage of the mains. The circuit may be tuned to the frequency of the A.C. from 53.

In order to make the ratchet wheel 40 rotate by one revolution it is sufficient to close the switch 52 periodically at the frequency T^1 first and T afterwards. This affords a very secure control of the wheel 40 as the device only works if the periodic impulses T and T^1 are continued for a sufficiently long time. Thus short induced currents operate the receiver and if any impulses are missed, the manner of working is not modified. The wheel 40 may moreover be actuated by a current of very small strength.

The different receivers may be provided with pendulums of different periods the coils of which are inserted in the same wires. According to the frequency of the supply current, some receivers may work and the others remain at rest.

In order to connect the transmitter with the receivers at the subscribers we may use known devices wherein no complementary wire is necessary. For instance, in the case of D.C. mains, a small alternator may be used at the central station, one of the terminals of which is earthed and the other of which is connected with the mains. At the subscribers a condenser may be inserted in series with the coils 54 and 55, one terminal of the condenser being earthed.

With A.C. mains a dynamo machine would replace the alternator and an induction coil would replace the condenser. The distant control without any pilot wire could be made by means of high radio or audio frequency auxiliary currents.

Our invention may be used with the usual time distributing systems to set receiving clocks right instantaneously by means of periodical impulses sent through the connecting wires between the master-clock and the receivers. The coil of the selecting relay pendulum would then be connected in series with the winding of the receiving pendulum and the device would have to work in a manner such that the periodical signals do not influence the oscillations of the receiving pendulum and the normal impulses do not act on the selecting relay pendulum.

In the case where the time distribution is provided through synchronization, a periodical current may be used for setting the clocks right, the period of said current being different from that of the current impulses controlling normally the receiving clocks.

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—A distant control device for synchronising clocks, of the type wherein rhythmical electric impulses are adapted to make a pendulous relay start oscillating gradually, said relay closing the control circuit when it has reached a predetermined amplitude, wherein the relay is constituted by an isochronous beam oscillating through the action of a magnet on a copper wire coil without any iron core, the shape and arrangement of said magnet and coil being such that this action is comparatively small and substantially constant for a given current passing through the coil and throughout the oscillations of the beam, the coil being moreover fed by an impulse receiving circuit which is supplied normally with uni-directional current the intensity of which decreases when the signal impulses are received.

2—A device as claimed in claim 1 wherein the pendulous relay is constituted by the known arrangement of a pendulum rod having a certain length and provided with a comparatively heavy magnet curved to a circular arc engaging the coil.

3—A device as claimed in claim 1 adapted to receive radiotelephonic impulses constituted by waves rhythmically modulated wherein the coil of the relay is inserted in the plate filament circuit of the ionic valve of a rectifying amplifier of the station adapted to receive the impulses.

4—A device as claimed in claim 1 comprising means adapted to give the amplitude of the oscillations a value which is always the same at the end of the signal whatever the length thereof, these means comprising for instance a stop in the path of the pendulum or beam, the desired control being provided at the moment when the amplitude of the oscillations decreasing after the end of the signal impulses passes below a given value at a predetermined moment with reference to the end of the signal, this control being effected in the case of the setting right of clocks by a heart shaped cam secured to the minute hand and engaged by a tooth actuated by an electromagnet the supply circuit of which is closed periodically by the relay as long as its amplitude is above the said predetermined value.

5—A device as claimed in claim 1 wherein all the gradually built up energy stored by the oscillating part is released suddenly in order to actuate the switch arrangement, this being provided for instance by the pendulum acting through a pawl on a ratchet wheel having a comparatively small number of teeth and causing it to rotate by one tooth only for a predetermined amplitude of oscillation, the ratchet when moving pushing a spring detent which closes a contact which is thus made and broken suddenly.

6—A distant control device as claimed in claim 1 wherein the receiver acts through a driving pawl on a ratchet wheel the interval between two adjacent teeth of which is solid, the signal being long enough to make the ratchet wheel rotate in all cases by more than one revolution, the ratchet stopping even when the signals continue when the driving pawl comes upon the solid interval, the ratchet being provided moreover with a detent pivotally secured to a rocking arm bearing a freely oscillating knife engaging a notched part secured to the pendulum whereby when the oscillations decrease at the end of the signal, the two parts are wedged together at a given moment so as to raise the detent and engage it with the next tooth and make the ratchet wheel rotate by one tooth after the fall of the detent bearing arm, the driving pawl being then in front of the first tooth after the solid interval which makes the working again possible at the next signal.

7—A distant control device as claimed in claim 1 wherein the impulse emitted comprises in succession two signals having the frequencies T and T[1] to which correspond two relay pendulums of corresponding period both acting on the same ratchet wheel having a solid interval, the first pendulum, serving for the reception of the control signal and having a frequency T, making the wheel rotate until its pawl falls on the solid interval and effecting the desired control whereas the second pendulum makes the ratchet rotate by a few teeth so as to allow its actuation at the next signal by the first pendulum.

8—A device as claimed in claim 1 for setting a clock right wherein the minute hand is frictionally secured to its spindle and can be returned to a given position with reference to the dial by the armature of an electromagnet acting on a cam to which the hand is secured, the hour hand being controlled by the minute hand and the time signals acting on the device ending always at the same minute of any hour corresponding to the setting right of the minute hand so that the time signal may be given every day at any one of twenty four predetermined moments.

9—A distant control device chiefly for setting clocks right substantially as described with reference to and as illustrated in the appended drawings.

Dated this 8th day of March, 1928.

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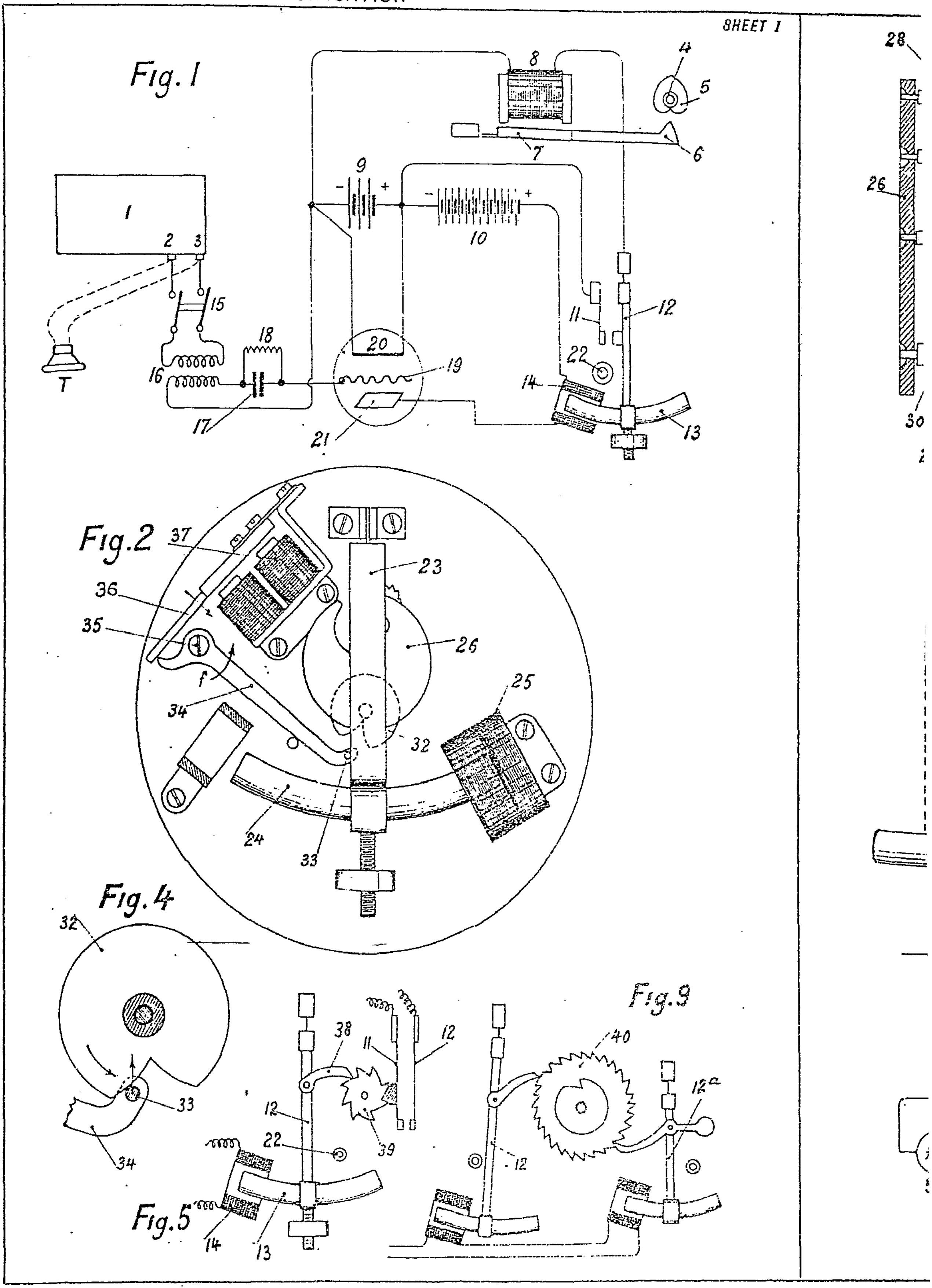

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Fig. 3

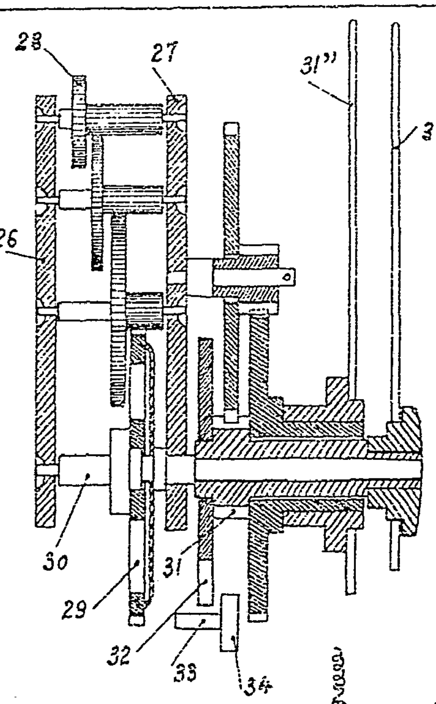


Fig. 6

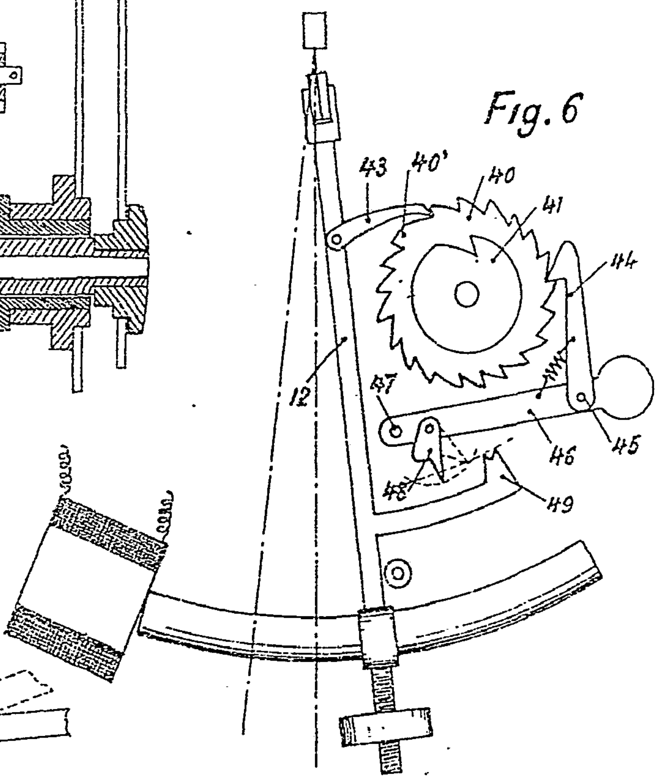


Fig. 8

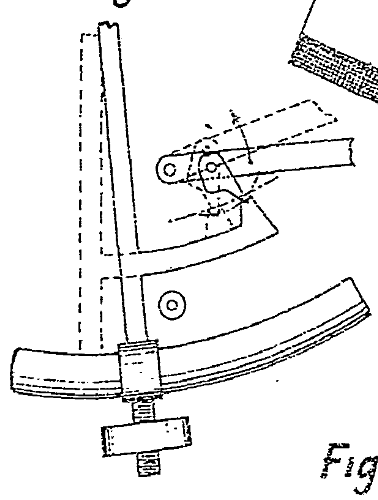


Fig. 7

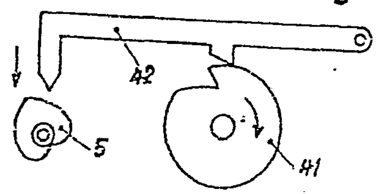
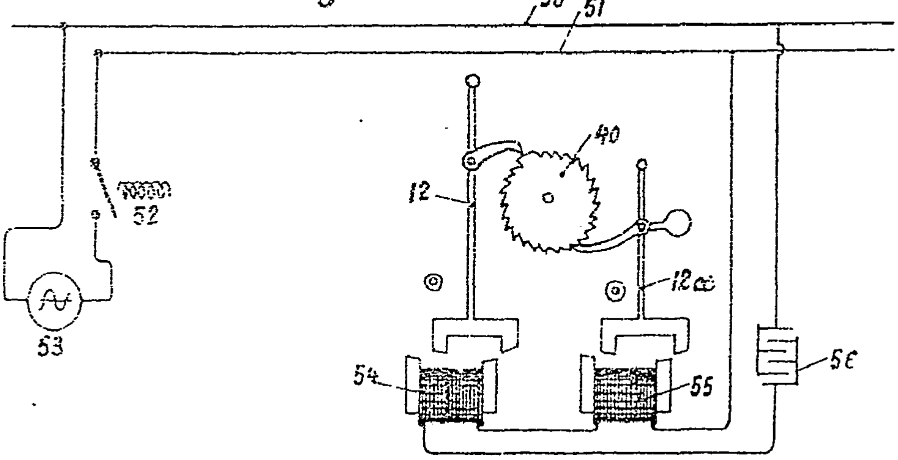


Fig. 10



2 SHEETS

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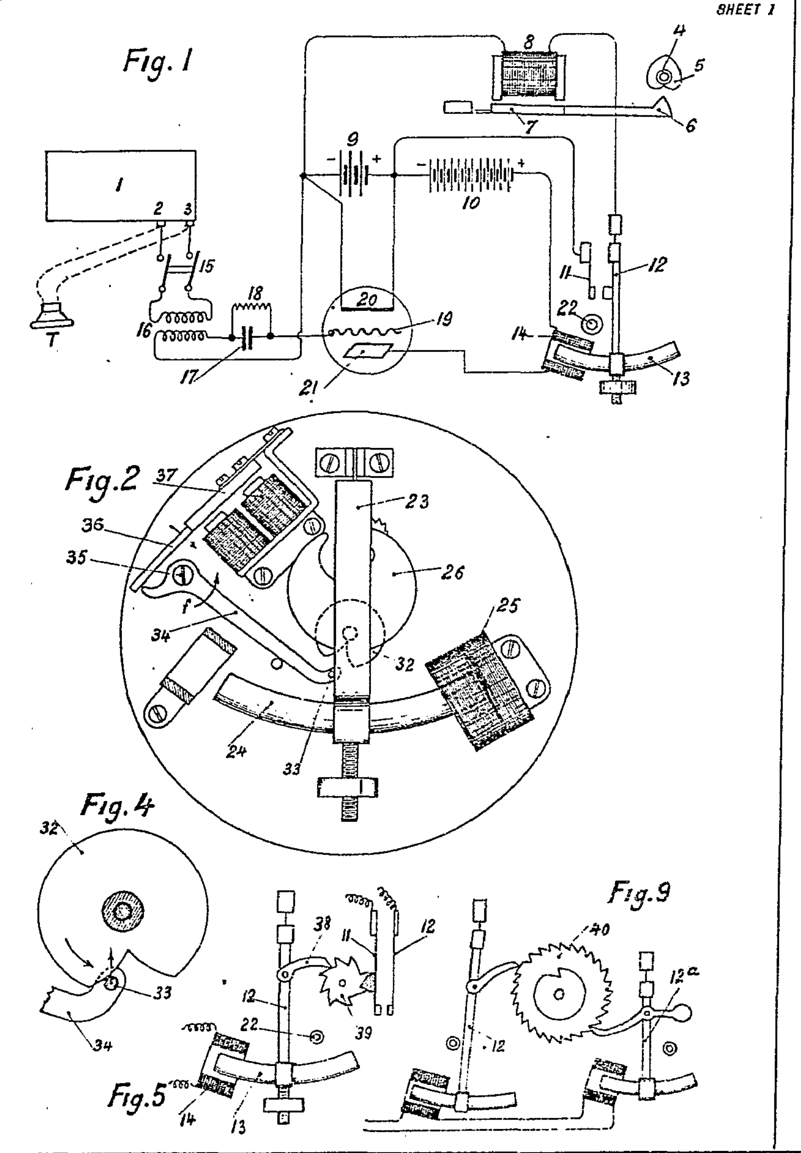

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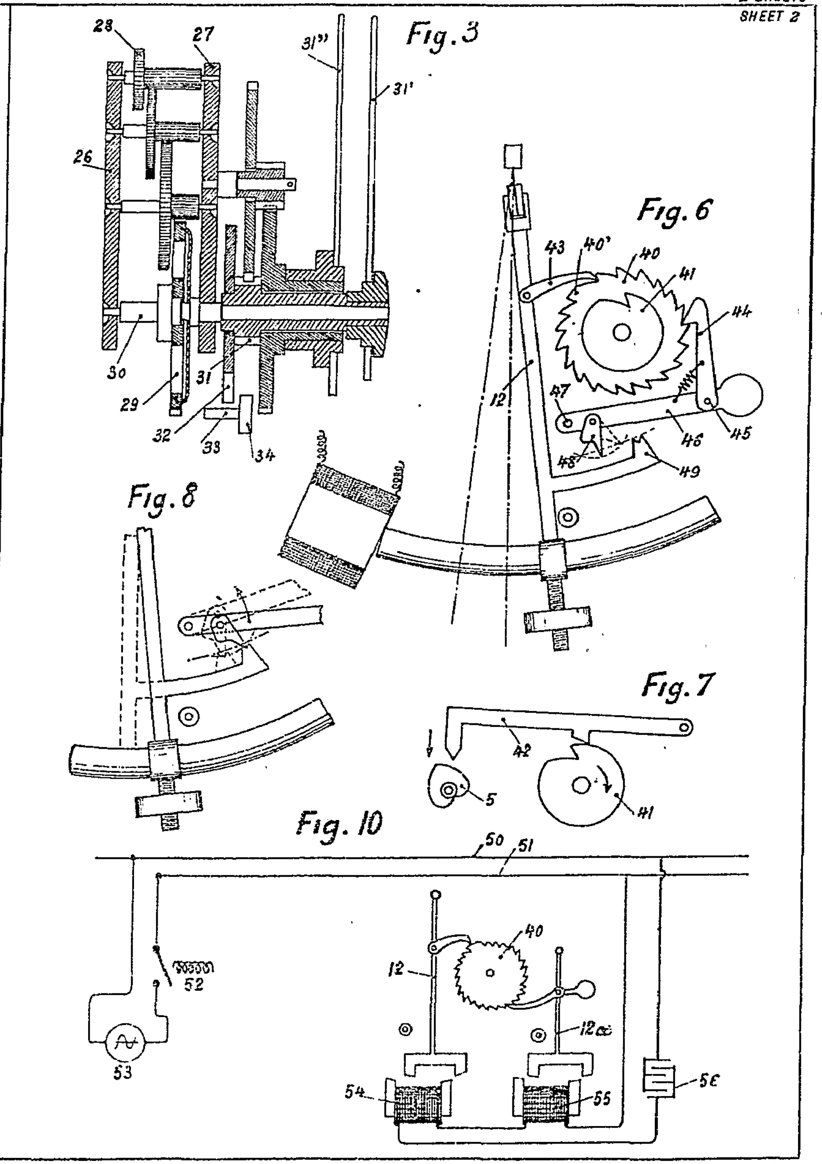

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