Note.—The application for a Patent has become void.
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PATENT SPECIFICATION

Application Date: Jan. 28, 1935. No. 2775/35. **456,050**

Specification not Accepted

COMPLETE SPECIFICATION

Method and Device for Regulating Electric Main Clocks by means of Electric Waves

We, N.V. RADIOKLOK, a Company registered under the laws of the Netherlands, as an incorporated Company of 46, Raamsingel, Haarlem, Holland, the assignees of FRITZ ISLER, a Citizen of the Swiss Confederation of 5, Usteristrasse, Zürich, Switzerland, 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:—

The subject of the present invention relates to a device for regulating electric clocks and master clocks, the regulation being effected by means of electric waves daily in clear periods after the course of 23 hours, the regulation during the subsequent hour effecting each minute the correction of the receiving clocks by a short wave impulse. To these receiving clocks (master clocks) there may be connected, by means of wire conductors, a number of auxiliary clocks, which agree, in a secondary action, in indicating time with the master clocks. Devices are known in which the correction of receiving clocks is effected every 24 hours by means of electric waves, but these operations have only taken place for a short time, one or more minutes, whilst any foreign waves which occur during the same time are liable to deleteriously affect the regulating operation. As in addition these receiving clocks have not been developed as master clocks it is not possible to connect auxiliary clocks thereto. It would also be difficult to use these receiving clocks as master clocks as the results of their movement, which must be regulated by electric waves, are partly minus and partly plus. It is not possible to directly set back auxiliary clocks as their minute movement, should this already have taken place, can only be effected forwardly. A further defect of these systems resides therein that the receiving clocks get out of regulation should the regulation transmission cease for a few days, which is liable to occur in practice.

The disadvantages are eliminated according to the present invention. For regulation there is used a normal clock of which the movement is so adjusted that the clock gains 30 seconds in one hour. It controls the electric wave transmitter selectively for half an hour or a complete hour at the time when the receiving clocks are prepared automatically for the reception of the regulating waves. The regulating transmitter comes into operation each minute in such a manner that each minute it transmits a wave impulse of about $\frac{3}{4}$ of a second duration which at each further minute takes place $\frac{1}{2}$ a second earlier. It thus acts on the receiving clocks which have lost in such a manner that these are released positively each minute for $\frac{1}{2}$ a second gain and this without being affected, should a foreign wave be received accidentally, as the receiving clock is only prepared for regulation for $\frac{1}{2}$ a second. Finally it may be mentioned that a method of regulation of master clocks is already known in which the correction of the master clock is effected every minute by means of electric waves. In contrast with this method of regulation the operating arrangement according to the present invention is considerably simpler, less expensive and more certain in operation. In particular possibilities of disturbance which may be caused by broadcasting, by which electric regulating waves are transmitted every minute from the central station, are eliminated. The receiving clock is also protected from local and foreign waves as this is positively screened from electric waves during the day period when all broadcasting and telegraph transmitters are in operation. The regulating operation is therefore preferably effected during the night for example between 2 to 3 a.m.: during this time the broadcasting stations are silent and cannot therefore be disturbed and they in turn will not disturb the wave clocks. Finally it may also be mentioned that in all systems which have become known hitherto it has not been recognised that the receiving clocks must lose in all cases.

As is well known various temperatures which occur, air pressure, moisture content of the air, vibrations and the like, have a deleterious effect on the clocks so that it is alternately necessary to consider a minus and plus difference. It has been possible by use of compensations for the pendulum and balance wheel to keep these differences within narrow limits but it is not possible to control these alternately over long periods. It should therefore be regarded as a considerable technical improvement to be able with the present invention to cause a clock, by means of simple inexpensive means, not to pass from minus differences of a few seconds within a period of 24 hours.

In the accompanying drawings is shown diagrammatically an example of construction according to the invention.

Fig. 1 shows diagrammatically a receiving clock.

Fig. 2 shows a clockwork with a device for preparing the receiving clock for wave reception in the prepared position.

Fig. 3 shows the same as Fig. 2 with a contact device open, the clock disengaged from wave reception and with an aerial earthing device.

Figs. 4 and 5 are views of the stopping and release position of the stopping member for the escapement wheel to a larger scale.

Figs. 6 to 12 show details.

The clock shown is provided with a clockwork for indicating the time, and a clockwork which drives auxiliary clocks, connected to the main clock, and also engages and disengages the receiving clock for the reception of regulating electric waves for a predetermined period of time, an automatic electric winding device being also provided, by means of which the springs of the various clockworks are retensioned.

In the regulating receiving clock 1 there is mounted in the plate 2 by means of the spindle 9^1 a minute wheel 7 of the clockwork. On the spindle 9^1 is rotatably mounted the spring housing wheel 4 in which a spiral blade spring 3 (Fig. 12) is hooked in the known manner at one end to the spindle 9^1 and at the other end to the wall of the spring housing 4. The minute wheel 7 engages with the toothed wheel 11 of the escapement wheel 10. The escapement 12 engages at one end with its hook with the teeth of the escapement wheel 10 and at its other end it co-operates with the balance wheel 13 which is under the action of the spiral spring 14. On the spindle 9^1 of the minute wheel 7 is also mounted the cam disc 8 which raises a fall hammer 43, 45, 46 and again allows this to fall. The spring housing 4 drives, through an intermediate wheel 15, the spring housing 122 (Fig. 11) of the clockwork for effecting the drive. The spring housing 122 is freely rotatable on the shaft 122c which carries the wheel 126. The outer end of the spiral spring 122a is secured to the rim 122b of the spring housing 122 and at its other end to the spindle 122c of the clockwork. On the wheel 126 is mounted a disc 126a which is provided at the rim with a recess 124 and carries a laterally projecting pin 23. The wheel 126 gears with the toothed wheel 125 of the brake disc 127 (Fig. 10). On the spindle of the brake disc 127 is mounted an air brake 125a which serves to regulate the movement of the clockwork.

On the plate 2 is rotatably mounted a bell crank lever 48 of which one arm is provided with a notch 48c (Figs. 4, 5) and of which the other arm projects into the path of the pin 23. The lever 48 is subjected to the action of the spring 50. In the plate 2 is also mounted a locking lever 55 with a locking tooth 53, its downward extension 52 serving as armature for an electromagnet 57. The locking lever 55 can stop the escapement wheel 10 by means of the locking tooth. The locking lever and thus the movement of the escapement wheel can be influenced both by the disc 126a, through the medium of the pin 23 and lever 48 and by the electromagnet 57. In the lever 55, subjected to the action of a spring 49, is mounted a pin 51, consisting of a gate or the like which can engage with the notches 48c of the lever 48 (Fig. 5). The electromagnet 57, secured to the plate 2, is connected by leads 58, 59, to a source of current 71. In the plate 2, there are mounted in electric insulating sleeves 94, 95, 96 the bolts of contact springs 91, 92, 93. To the contact spring 93 is connected the lead 61, to the contact spring 92 the lead 60 and to the contact spring 91 the lead 59. The contact springs 91, 92, 93 are actuated by an actuating disc 21 which is keyed to the spindle 122c of the disc 126a and of the wheel 126, the contact springs 91, 92 being first moved and then somewhat later the contact spring 93 and thus the circuits hereinafter described are closed in sequence.

On the plate 2, is mounted the locking and brake lever 112 which at one end is provided with a horizontal arm 111 and with a vertical arm 112^1. The latter is provided with a locking tooth 114 and a circular recess 113. The arm 112' can be pressed against the disc 127 by a spring 115, when the locking tooth 114 can enter the recess of the disc 126a, so that the clockwork is thus braked and stopped. The arm 111 projects into the path of pins 18 of a pin wheel 17. The pin wheel 17 is rigidly connected to the toothed wheel 16 which gears with the wheel 128. Each pin 18 can move the lever 112 against the action of the spring 115.

On the plate 2 is mounted an electric winding mechanism for the spring 3 of the clockwork. The winding mechanism is provided with a bell crank lever 42, bearing against the pin 47, which can be moved by the fall hammer 45 against the action of the spring 44. One arm of the lever 42 forms a ratchet pawl 41. The latter co-operates with a bell crank lever 38, 39 subjected to the action of a spring 38a, which serves to close the circuit through an electic winding motor 30. The electric winding motor 30 drives through the clutch 148, 149, worm and worm wheel 136, 129 a brake disc 144 and through the gear train 133, 134, 135 an actuating disc 120, secured to the toothed wheel 128. The rotations of the motor 30 are transmitted by the wheel 128 through the intermediate wheel 123 to the spring housing 122 of the clockwork and from here through the intermediate wheel 15, to the spring housing 4 of the main clockwork. Against the brake disc 144, mounted on the spindle of the wheel 129, there bears a brake lever 145. To the latter is rigidly connected a lever 131 of which one arm 146 bears against the lever 38. A projection 147 on the lever 131 projects into a recess 143, of a disc 120. On the shaft of the actuating disc 120 is mounted an actuating arm 22 which co-operates with a projection 40 of the lever 38.

The motor 30 is stopped in that the actuating arm 22, rotating with the disc 120, depresses the projection 40 of the lever 38 whereby the motor circuit is opened at contact 37, 39 whilst the lever 131 engages, by means of its projection 147, with the recess 143 of the actuating disc 120. The brake lever 145 presses against the disc 144 and stops the motor 30. The pawl 41 is rocked by the spring 44 into its locking position upon the lever 38 and thus secures the lever 131 in its locking position.

The motor 30 is connected by one pole and by the lead 35 to the insulated contact 37 on the plate 2, whilst the other pole of the motor is connected by the lead 31 to the minus pole of the battery 34; the plus pole of the latter is conductively connected to the plate 2.

The clockwork described drives the auxiliary clocks 84. With the wheel 125 there meshes the toothed wheel 16 to which is rigidly secured the wheel carrying the pins 18. The wheel 17 drives a toothed wheel 89 to which is secured a cam 90. The latter acts on two contact springs 85, 86 which, together with a bar 87 are secured to an insulating member 88. The springs 85, 86 are connected by the leads 82, 83 to the auxiliary clocks 84. The contact bar 87 is connected, by the lead 78, to the minus pole of the battery 79, whilst the minus pole of the latter is connected by the lead 80 and the contact screw 81 to the plate 2.

Any suitable number of auxiliary clocks 84 may be driven. These auxiliary clocks, driven by the receiving clock described, may be of known construction and may be arranged at any suitable distance, the hands thereof being moved forwardly in jumps.

The clockwork also controls a wave receiver (ionisator) 66 which, when rendered conductive in the known manner by electric waves, closes, and so forth, the circuit of the electro-magnet 57. Into the path of the pins 18 of the wheel 17 projects one end 77 of a double armed lever 75 which at the free end carries a hammer 74 and is subjected to the action of a spring 75a (Fig. 9). The hammer 74 can strike against the wave receiver 66 when a pin 18 moves the lever 75, 77 against the action of the spring 75a. The wave receiver is mounted in a support 64. At the top of this is mounted the U-shaped bearing 67 in which the wave receiver (ionisator) 66 is rotatably mounted by means of the pivots 68, 69. To the foot 62 is connected the lead 60 and to the support 65 the lead 58. The lead 60 leads to the contact spring 92, the lead 58 to the contact spring 93 and to the battery 71. From the latter the lead 70 passes to the electro-magnet 57 which is connected by the lead 59 to the contact spring 91 (Figs. 1, 6, 7 and 8). Figs. 6, 7 and 8 show the switching operations which occur successively.

In order to prepare the clockwork for regulation by the waves there is provided the device shown in Figs. 2 and 3. This device is provided with an auxiliary clock 34 to which lead the leads 82, 83. The 24 hour wheel 101 of this auxiliary clock 84 carries a pin 102. Near the wheel 101 there are rotatably mounted in bearing bushes 99, 100 the striking hammers 103, 104. In the base plate of the auxiliary clock 84 are also mounted the contact springs 105, 106 of which the movements are limited by the stops 107, 108. The contact springs are included in the lead 58 which passes from the wave receiver 66 to the electro-magnet 57. Fig. 2 shows the closed contact and Fig. 3 shows the open contact. At a certain time, for example, from 2 to 2.30 a.m. the contacts 105, 106 are kept closed and thus the regulation of the receiving clock hereinafter described is rendered possible.

In Fig. 3 is shown in combination with the contact spring 105 an aerial earthing. Of the two contact springs 150, 151, the spring 150 is connected to the aerial and the spring 151 to earth 153. The back 154 of the contact spring 150 is insulated.

In the drawing is shown the position of contact between 150 and 151 which is maintained from 2.30 a.m. to about 1 a.m. on the next day.

The regulation of the receiving clock under the action of the electric regulating waves is as follows: The clockwork of the receiving clock 1, which amongst other devices includes the gear train 4, 7, 8, 9, 10, 11, 12, 13, 14, is regulated by the balance wheel 14 and escapement 12 and initiates the switch operations from minute to minute. During each minute the wheel 7 makes a complete revolution and the cam 8 thus allows the fall hammer 45 to fall on the arm 42 of the pawl 41 every minute and moves the latter downwardly against the action of the spring 44. The projection 41 slides off the lever 38 which then, under the pull of the spring 38a closes the contact 37 by means of its contact spring 39. The circuit 2, 38, 39, 37, 35, 34, 31, 32 of the electric motor 30 is closed and the latter rotated. At the same time the lever 38 has met the arm 146 of the lever 131 which has been raised and raised the brake arm 145 from the brake disc 144. The motor is released for rotation and now rotates the members 149, 148, 136, 129, 133, 134, 135, 128, 132, 133, 122, 15, 4, 16, 17 and 89. The spring 122a of the clockwork and the spring 3 of the clockwork are thus tensioned every minute. The following operations are thus caused to take place in sequence: the pin wheel 17 engages, by means of one of its pins 18, the arm 77 of the lever 75, whereby, as the arm 77 slides off, the hammer 74 strikes the ioniser 66. Further the wheel 16 rotates the wheel 89 through half a revolution, whereby the auxiliary clock circuit 82, 83 is closed and again interrupted. The auxiliary clocks 84 are thus advanced by one minute. Shortly before the motor 30 stops one of the pins 18 depresses the arm 111 of the lever 112. The arm 113 of the lever 112 is thus raised from the brake disc 127 of the wheel 125, whilst the pin 114 on the lever 112 moves out of the notch 124 of the disc 126a. The driving train 125, 127, 126, 126a, 122c is thus released and rotates under the action of the spring 122a, whilst the air brake 125a regulates the movement of the clockwork, that is to say, determines the speed of rotation of the actuating disc 21 and of the actuating disc 126a with pin 23. The time interval for stopping and releasing the escapement wheel 10 by the locking tooth 53 can thus be accurately determined. After the completion of the rotation of the wheel 126 the pin 114 mounted on the lever 112 again passes into the recess 124 of the disc 126a under the action of the spring 115 and at the same time the disc 127 is stopped by the brake lever 112, 113. Shortly after the disc 126a has been released by the locking pin 114, the pin 23 strikes against the lever 48 and thus rocks, whereby the pin 51 has been released from the notch 48c of the long arm of the downwardly moved lever 48 (Fig. 4). The spring 49 can now rock the locking lever 55 until its hook 53 engages with the escapement wheel 10 and stops this. The armature 52 has simultaneously moved away from the magnet 57. The actuating disc 21, rotated by the clockwork, before the pin 23 has moved the lever 48, is not yet engaged with the contact springs 91, 92, 93 (Fig. 4) so that the circuit 67, 65, 58, 71, 70, 57, 59, 60, 64, 67 formed by the wave receiver 66 is still interrupted by the spaced contact springs 91, 92, 93. During the further rotation of the actutating disc 21 this presses against the contact spring 91 and during further rotation presses it against the contact spring 92 (Fig. 7).

Assuming that the lead 58, 65, is still interrupted in the auxiliary clock 84 (Figs. 2 and 3) the above described receiving circuit would also still be open, i.e. the incoming waves would have no effect on the electro-manget 57. If, however, it is assumed that the lead 65, 58 is still interrupted but that the actuating disc 21 during its further rotation has brought the contact springs 91, 92, 93 into contact then by bridging the wave receiver 69 only the circuit 93, 58, 71, 70, 57, 59, 91, 92 is closed by 93. As a result the electro-magnet armature 52 (Fig. 1) is attracted by the electro-magnet 57 and the locking lever 53 is withdrawn from the teeth of the escapement wheel 10. The clockwork is again set in operation. When the actuating disc 21 passes off the contact springs 91, 92, 93, whereby the circuit through the electro-magnet 57 is again broken, the locking tooth 53 cannot return under the pressure of the spring 49 into the teeth of the escapement wheel as the pin 51 passs into the notch 48c of the lever 48 and is there held against the action of the spring 49. Preceding these switching operations the pin 23, mounted on the actuating disc 126a, has engaged with the lever arm 48, rotatably mounted on the plate 2 and subjected to the pressure of the spring 50, and thus moved its lateral arm with its notch 48c downwardly whereby the locking lever 53 could enter the teeth of the escapement wheel under the pressure of spring 49. This condition thus constitutes an automatic electric clock which is wound by an electric motor every minute and which is stopped every minute for a fraction of a second and is again released for movement.

A clockwork of which the speed is regulated by the air brake 125a closes the circuit through the electro-magnet 57 prematurely so that the escapement wheel is stopped for half a second. As the oscillations of the balance wheel 14 are adjusted for the purpose of gaining, the receiving clock would gain about 12 minutes in 24 hours. By the stopping which occurs positively every minute and by a slight adjustment of the setting pointer of the spiral spring 14 it is possible to regulate with ease the movement every 24 hours so that there is a loss of from 5 to 10 seconds.

The receiving clock together with the auxiliary clocks 84 connected thereto are therefore left to themselves for 23½ hours.

For example at 2 o'clock the hammer 104 falls, it closes the receiving circuit (Fig. 6), the receiving clock is set ready for the reception of electric waves. As long as the circuit is open at the contact springs 91, 92, 93 foreign or local waves which might reach the ionisator 62 are ineffective. As, however, the ionisator reacts to electric waves it is first struck or somewhat shaken by the hammer 74, 75 moved by one of the pins 18. When subsequently there is effected by the actuating disc 21 the first contact closure (Fig. 5) of the two contact springs 91, 92 and if at the same time the ionisator is energised by an electric wave, it becomes electrically conducting and closes the circuit 66, 67, 64, 60, 92, 91, 59, 57, 70, 71, 58, 105, 106, (Fig. 6) 58, 65, 67, 66. Consequently the electro-magnet armature 52 of the electro-magnet 57 is attracted so that the locking lever 53 cannot engage with the escapement wheel. The clockwork is thus free and runs whilst gaining by about half a second. The resultant contact closure by the spring 93 (Fig 8) does not produce any fresh action; it only shortens the circuit and relieves the wave receiver.

The wheel 126 now stops whilst the pin 114 on the lever 112 again engages, under the pull of the spring 115 (Fig. 1) with the recess 124 of the disc 126, whilst at the same time the disc 127 is stopped by the brake recess 113 of the lever 112. Before the actuating disc 21 during its rotation reached the contact spring 91, the electric motor 30 had stopped, as the actuating arm 22 on the disc 120 had depressed the projection 40 of the lever 39. Contact 37, 39 is thus broken and the lever 131 engages by its projection 147 with the recess 143 of the actuating disc 120, and the brake jaws 145, press against the disc 144 thus stopping the motor 30.

These operations take place every minute for half an hour where possible during the night, preferably between two and three a.m., when broadcasting has ceased so that no disturbances are to be expected therefrom. During this time the two transmitting clocks I, II at the transmitting central station are switched in by hand for transmitting the regulating waves in such a manner that the normal clock I at 2 a.m. Observatory Time effects its transmission every minute for a duration of one second, whilst the normal clock II, which is regulated so as to gain half a second per minute, commences its transmission at 1 hour, 59 minutes 30 seconds a.m. In the receiving clocks these wave transmissions operate as follows: The receiving clock 1 is prepared for the reception of the regulating waves by the auxiliary clock 84. At the moment at which the contact disc 21 (Fig. 7) has closed the contacts 91, 92, the regulating wave of the normal clock II has energised the ionisator which has lost the most. The escapement wheel 10 is not stopped by the tooth 53 as the locking hook 53 (Fig. 3) has been held back by the attraction of the electro-magnet armature 52. These operations take place in the same manner in all the receiving clocks untill all the clocks 1, which have lost have been influenced by the advance wave transmissions of the normal clock II, and have been advanced to normal time, whereupon the normal clock I alone influences the clocks by its transmission. The regulating movement of the wave transmitted by the normal clock II is carried out at folows: during the first minute the transmission of the normal clock II takes place with a gain of half a second, the second minute with one second, the third minute with 1½ seconds and so on until after the lapse of thirty minutes it coincides with the transmission of clock I. The transmissions are then stopped by hand. At the receiving clocks there then occurs the automatic opening of the receiving circuit in that the second and heavier hammer 103 passes off the pin 102 of the 24 hour wheel and whilst falling presses the contact spring 106 downwardly against its seat and thus separates the two springs 105, 106, the aerial being simultaneously connected to earth 153. All the receiving clocks now continue to operate as self contained electric clocks. that is to say without any regulation by means of electric waves.

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. Electric clock system with receiving clocks, regulated by electric waves, to which auxiliary clocks are connected, characterised in that the clockwork of the receiving clocks is so regulated that the clock gains, but that during each minute the clockwork is stopped for a short period of time and is again released in such a manner, for example, that after 23 hours the clock has lost a few seconds, and that the setting of the clockwork to observatory time is effected by electric waves by co-operation of two clocks at a transmitting central station, one of these clocks moving according to observatory time and transmitting a regulating wave each minute, whilst the second clock at the transmitting central station is so adjusted that it gains ½ a second per minute of observatory time and also transmits waves each minute, whilst for setting the receiving clock the stopping of the clockwork is interrupted wholly or partly for such a time until the wave transmissions of both clocks coincide.

2. Clock system according to claim 1, wherein the clockwork of the receiving clock which is adjusted so as to gain is periodically stopped and the stopping is again interrupted for a selectable period of time by means of electric regulating waves, characterised in that a locking member (53) which is released every minute by clockwork (122^1, 126) of the receiving clock and stops the escapement wheel (10) of the clockwork, is under the action of an electro-magnet (57) in the circuit of which, which circuit is closed once every minute by the clockwork, there is included a wave receiver (66) by which the electro-magnet is energised by the incoming regulating waves in sequence and the stopping of the clockwork effected by the clockwork (122^1, 126) is rendered wholly or partly inoperative.

3. Clock system according to claims 1 and 2, characterised in that the clockwork (122^1, 126), by means of an auxiliary clock (84) and a switch (105, 106) actuated by the latter, prepares the receiving clock (1) for the reception of electric regulating waves at a suitable period of time of the day and remains prepared for a predetermined period of time, for example, for half an hour or one complete hour.

4. Clock system according to claims 1 to 3, with a clockwork serving for regulation, characterised in that the operations set up by the clockwork (122^1, 126) take place first, whereupon there subsequently occurs a regulation by means of electric waves for the purpose of eliminating from the regulating operation the influence by means of local electric waves.

5. Clock system according to claims 1 to 3, with a clockwork serving for regulation, characterised in that the clockwork which actuates the contacts (91^1, 93) for effecting the regulation and the stopping members (113, 114), is driven purely mechanically by its own driving means (tension spring 122*a*) so as to ensure the constant speed of rotation thereof.

6. Clock system according to claims 1 to 5, characterised in that the clockwork (122^1, 126) sets into and out of operation every minute, an electric motor which retensions the spring (3) of the main clockwork and the spring (122*a*) of the clockwork.

7. An electric clockwork system, substantially as described with reference to the accompanying drawings.

Dated this 28th day of January, 1935.

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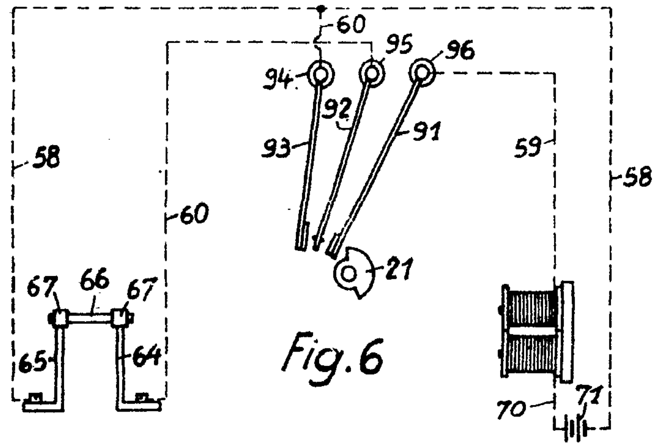
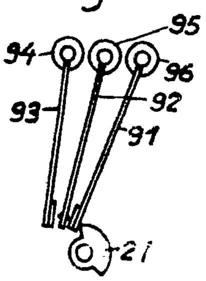


Fig. 6

Fig. 7



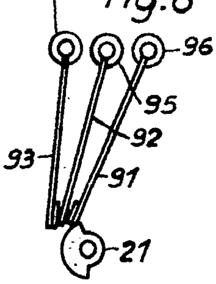


Fig. 8

Fig. 9

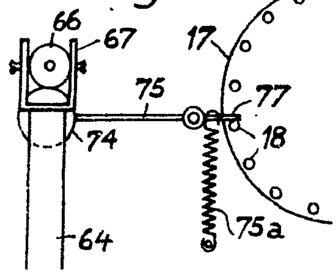
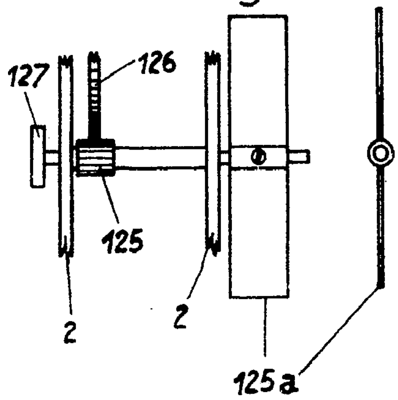


Fig. 10



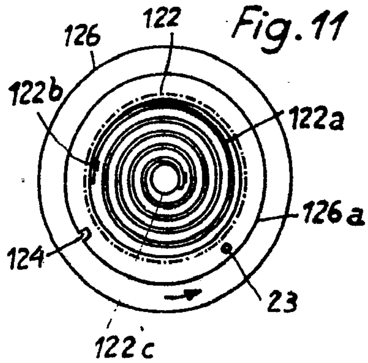


Fig. 11

Fig. 12

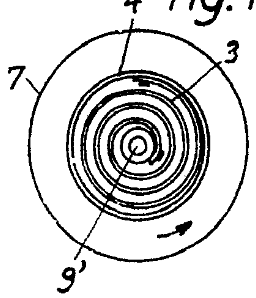


Fig. 1

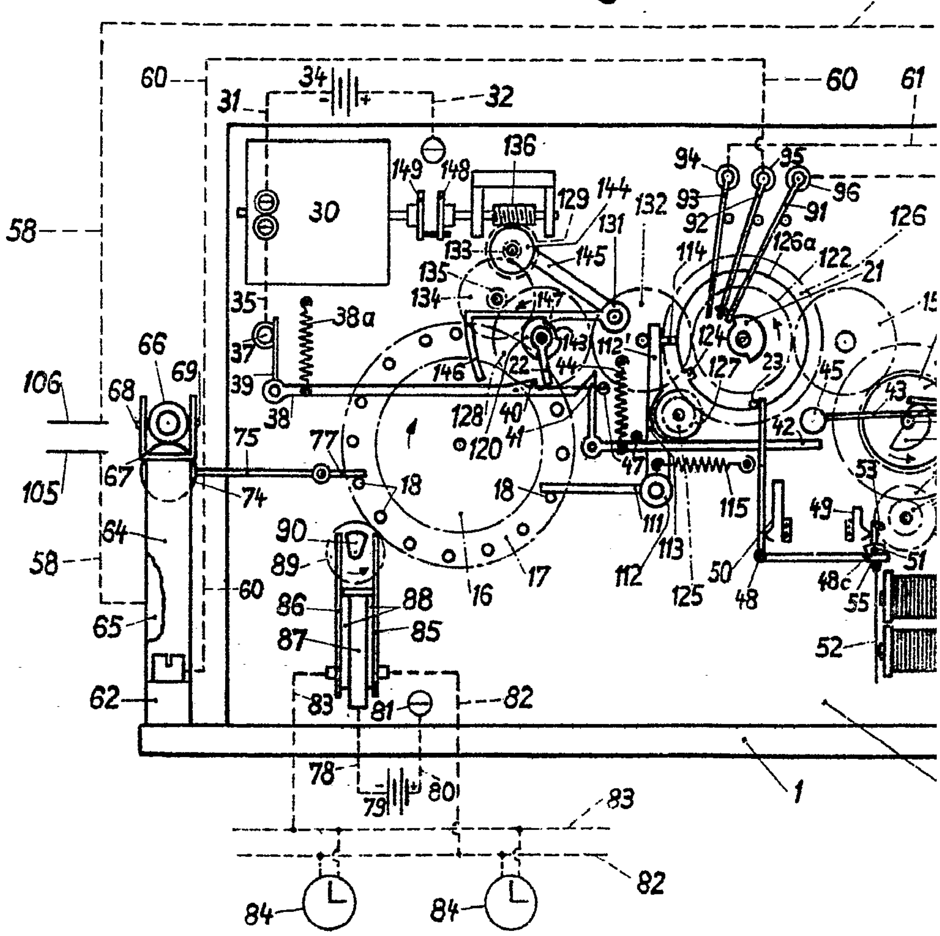
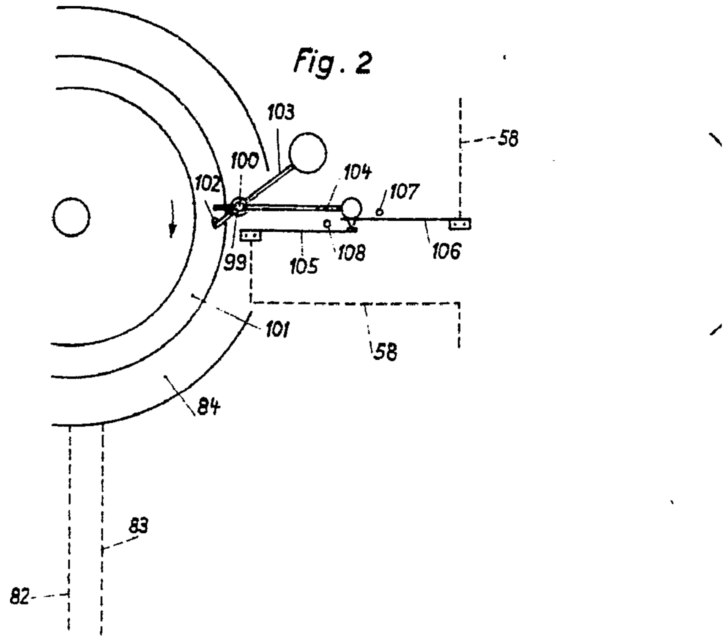


Fig. 2



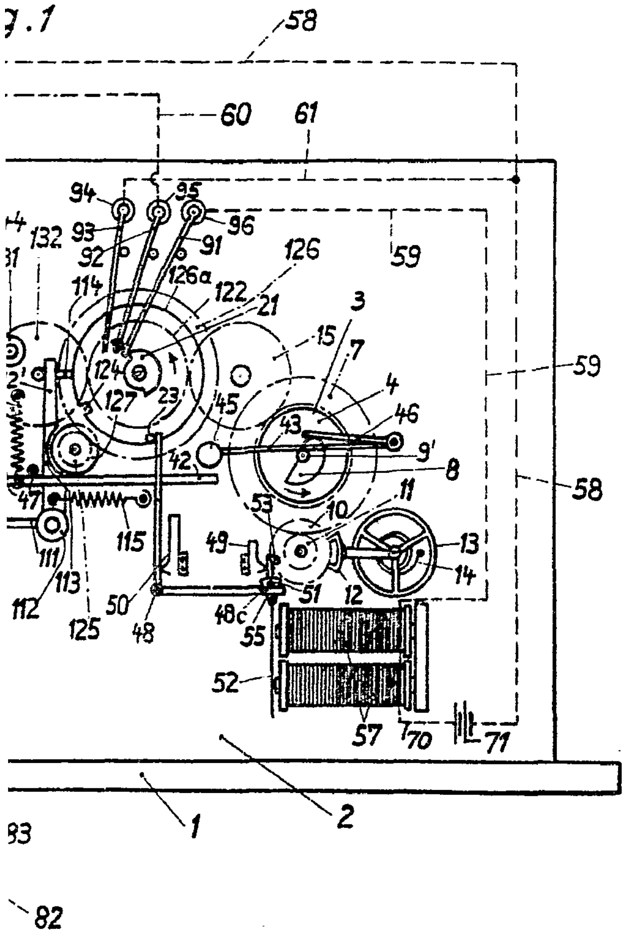


Fig. 4

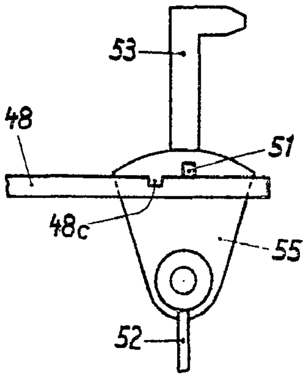
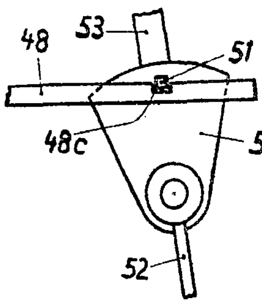


Fig. 5



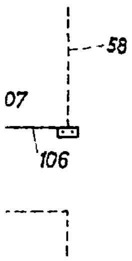
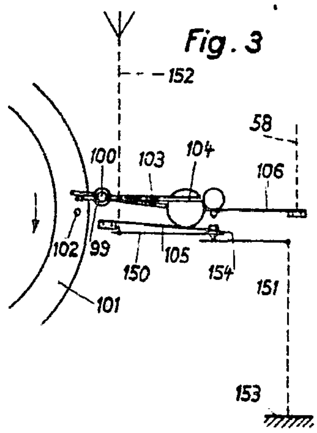
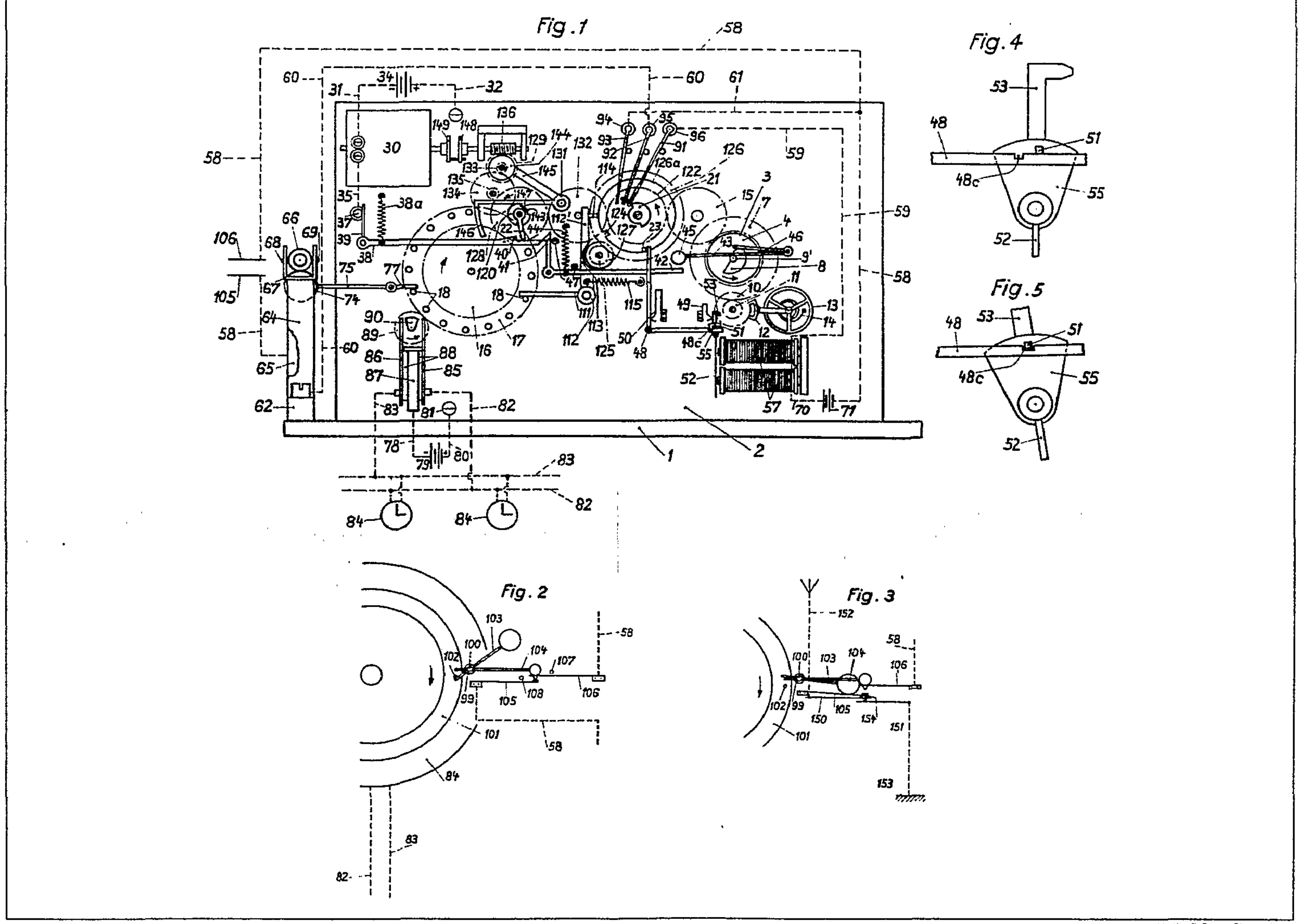


Fig. 3





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