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MECHANISM FOR REGULATING SYNCHRONIZING IMPULSE TRANSMISSIONS

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FIG. 1

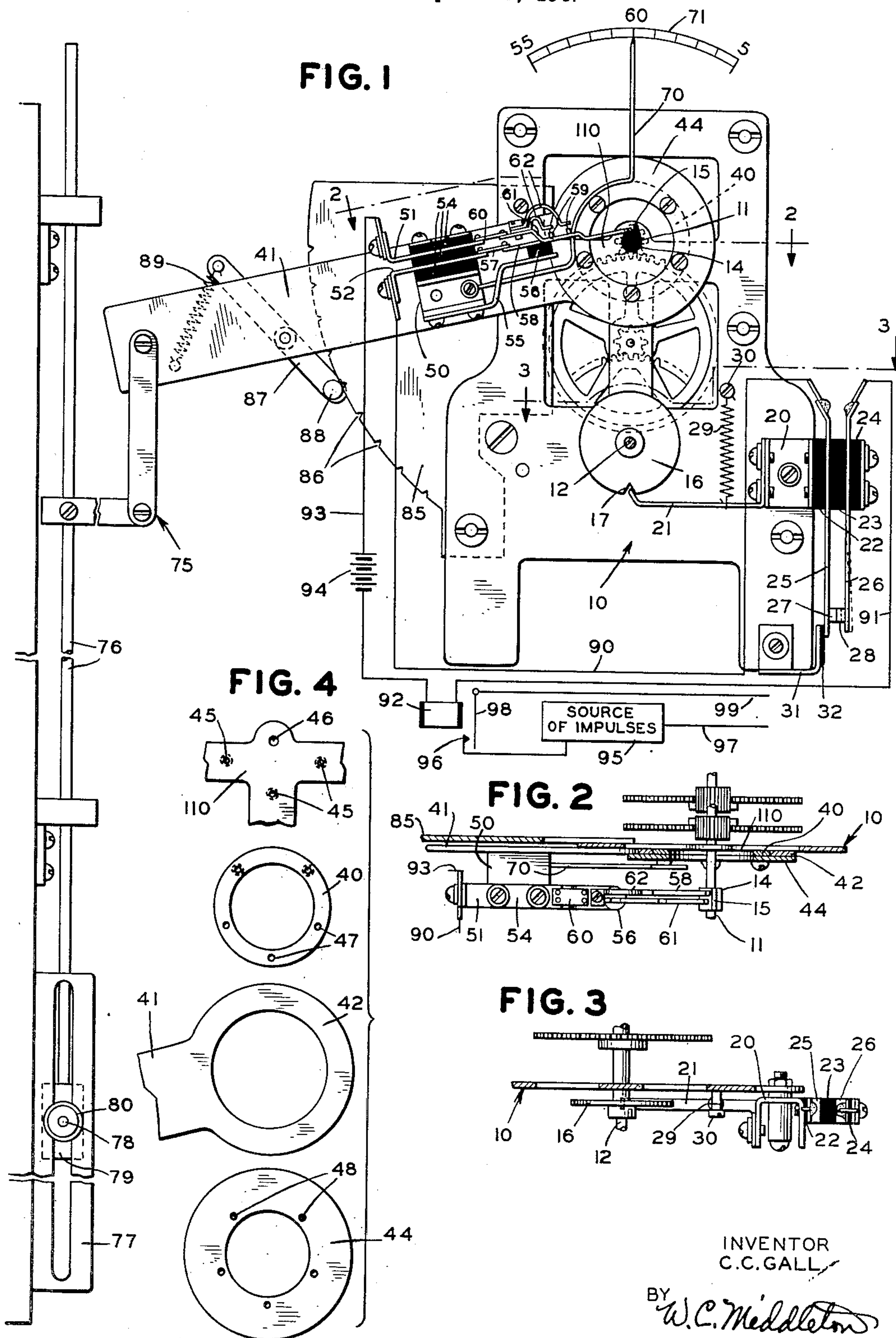


FIG. 4

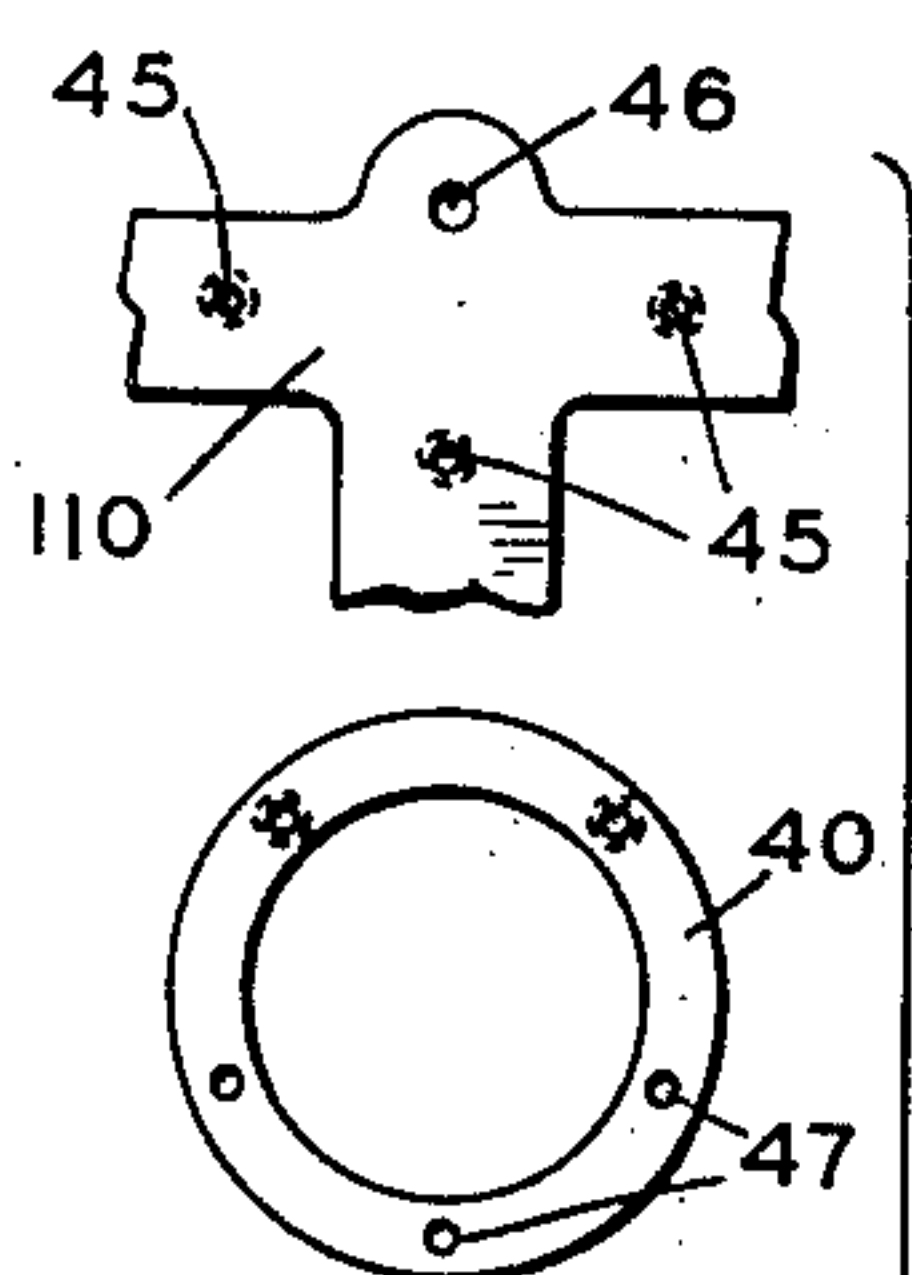


FIG. 2

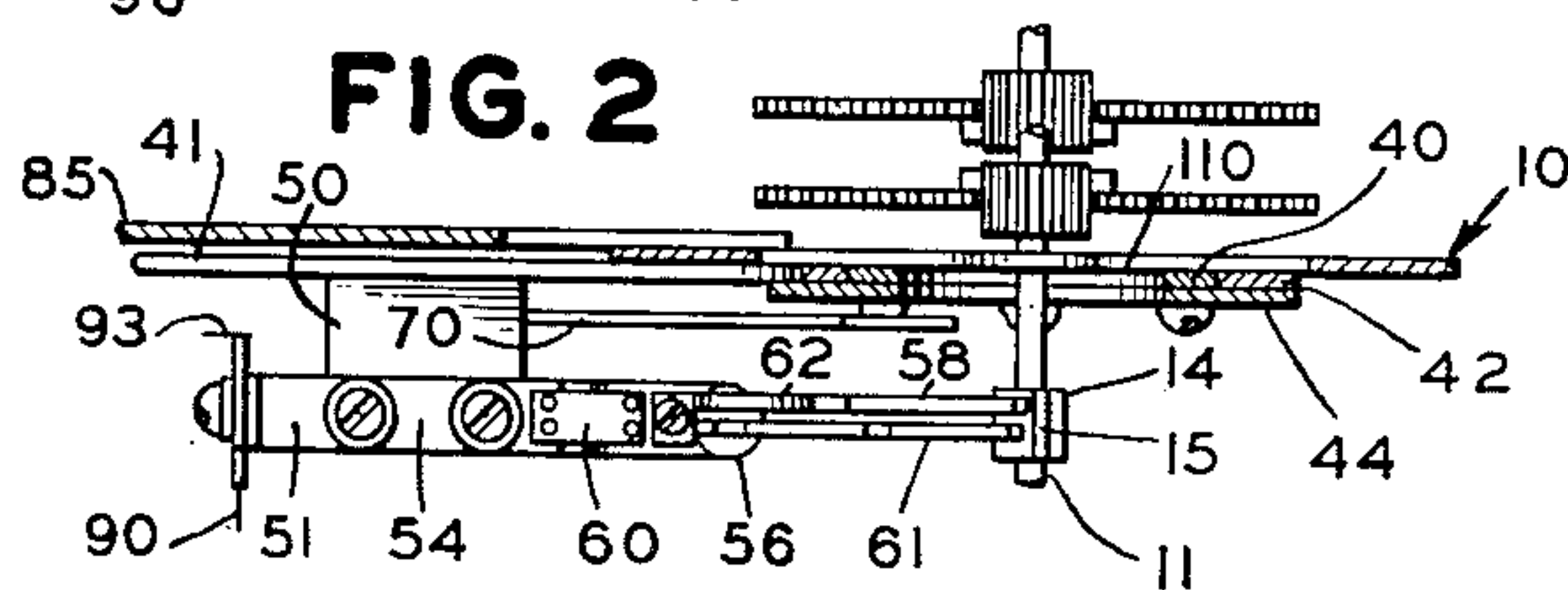
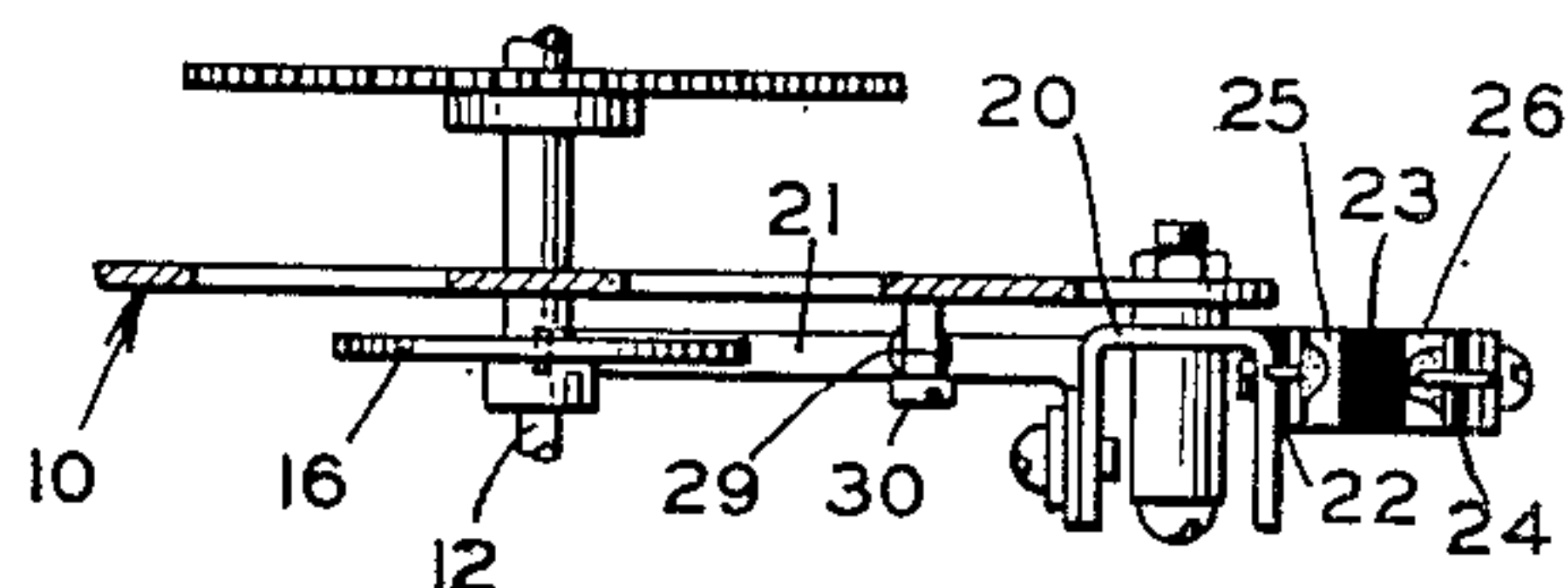


FIG. 3



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## UNITED STATES PATENT OFFICE

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## MECHANISM FOR REGULATING SYNCHRONIZING IMPULSE TRANSMISSIONS

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6 Claims. (Cl. 58—33)

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This invention relates to mechanism for regulating the transmission of impulses and more particularly to apparatus for regulating the transmission of synchronizing impulses by a master clock to its satellite clocks.

In service, i. e., the automatic regulation of a plurality of clocks at various points by a master clock, it is customary to transmit synchronizing impulses under the control of the master clock at regular periodic intervals, usually once each hour. The synchronizing impulses are of relatively short duration, usually one and a half seconds, and the end of each period of impulse transmission is the time reference point. Such impulses are transmitted to coincide as accurately as possible with standard time signals such as those supplied by the Naval Observatory or by some other standard. However, master clocks often are found to run at a slower or faster rate than standard, with the result that the synchronizing impulses may not coincide with the time standard. Heretofore efforts have been made to correct or regulate the master clock either by adding or by subtracting weights from the pendulum so that the clock can in time be made to transmit synchronizing impulses accurately. However, such regulation of the clock must be carried out over a relatively long period of time in order that the working of the master clock may not be interfered with, and consequently it follows that the satellite clocks may not be regulated to cause the time indicated thereby to coincide precisely with the standard.

An object of the present invention is to provide mechanism whereby a master clock can be regulated at will to compensate for any slowness or fastness in operation thereof so that synchronizing impulses can be transmitted in coincidence with the time indicated by some recognized standard.

Another object of the invention is to provide in a master clock contacts controlling the transmission of synchronizing impulses, which contacts can be closed for the desired interval at any time within a predetermined period to permit regulation of such synchronizing impulses relative to a standard.

Another object of the invention is to provide a master clock mechanism wherein the closing contacts are closed at regular intervals, i. e., once each minute, such closing of contacts serving to control the transmission of synchronizing impulses only when contacts in series with the first contacts are closed for a predetermined time interval periodically, i. e., once each hour, with adjustment being possible to vary the closing of the first contacts relative to but during the time interval of the closing of the second contacts.

Another object of the invention is to provide an arrangement whereby contacts which are closed under control of a cam on the seconds shaft of a

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master clock are movable relative to such cam to delay or advance the time at which such contacts are closed.

A further object of the invention is to provide means readily accessible for performing such regulation upon a clock normally mounted at a considerable distance above an attendant.

In carrying out the foregoing and other objects of the invention, a master clock is constructed for the major part in conventional manner. Such clock is provided with a cam of insulating material mounted on the seconds arbor or shaft, which cam has bearing against the surface thereof a pair of contacts which are mounted upon a member movable in an arc about the axis of the seconds shaft. These contacts are in series with a second pair of contacts normally open but which are closed periodically by engagement of a cam follower with a recess or notch in a cam secured to the minute arbor or shaft of the clock. This recess or notch is of such shape and size as to permit the second pair of contacts to be closed once an hour over a time interval of predetermined length, such as for example, forty seconds, divided into twenty seconds before the end of an hour and twenty seconds immediately after the end of an hour. In this manner forty seconds are provided for carrying out regulation of the transmission of the impulses. If the clock is in perfect adjustment, i. e., so running that the end of an hour falls exactly at the end of a standard time signal, the movable contacts before mentioned are so positioned that they are closed one and a half seconds prior to the end of an hour and opened exactly at the end of the hour. During such period of closed contact condition of one and a half seconds, a synchronizing impulse is transmitted by the master clock to all the satellite clocks associated therewith, which clocks have mechanism incorporated therein for moving the hands thereto to end-of-hour position and holding the same for the complete duration of the synchronizing impulse. When this impulse terminates, the satellite clocks then are in perfect synchronism with the master clock.

However, should the master clock be running fast or slow relative to a standard, such condition can be noted by an attendant of the master clock by comparing the hands thereof with the standard signal, and adjustment or regulation be made to compensate for such condition at the next period of synchronizing impulse transmission. For example, if the master clock is running three seconds faster than perfect operation, the member carrying the first set of contacts can be moved through an arc of 18° which will retard the time of closing and subsequent opening of these contacts by three seconds. Likewise, should the master clock be running slow, movement of the contact carrying member in the opposite direction through a suitable



number of degrees will advance the circuit closing and opening cycle of the contacts the proper number of seconds. For facilitating such regulation of the clock, a suitable scale and pointer are to be provided for indicating the angular movement of the contact carrying member. Inasmuch as master clocks are usually mounted at a relatively high point on a wall, provision is made in the present invention for permitting an attendant to carry out the regulation before described without approaching the level of the clock. For this purpose a sliding rod is connected to the contact carrying member in such fashion that vertical movement of the rod either upwardly or downwardly will cause either advance movement of the contact member or retard movement thereof relative to the end-of-the-hour standard.

Other features, objects and advantages of the invention will become apparent by reference to the following detailed description of the accompanying drawings, wherein:

Fig. 1 is a front view of a part of a clock mechanism showing the parts necessary for a complete understanding of the present invention;

Fig. 2 is a section taken substantially on the line 2—2 of Fig. 1;

Fig. 3 is a section taken substantially on the line 3—3 of Fig. 1; and

Fig. 4 is a collective view of some of the parts embodied in the invention.

Referring now to the drawings, and particularly to Fig. 1, 10 indicates generally a frame for a clock mechanism, such frame being shown with parts of a clock mechanism attached thereto. Such parts comprise a seconds hand arbor or shaft 11 and a minute hand shaft or arbor 12 connected by suitable gearing. The remaining parts of the clock mechanism, such as the driving motor and so forth, have been omitted. Secured to the seconds arbor is a cam 14 preferably made of suitable insulating material such as a phenol condensation product or the like. This cam 14 has a lobe 15 so extending from the body of the cam as to provide a sharp shoulder. Secured to the minute arbor 12 is a cam 16 which can be made of any suitable metal and which is provided with a recess 17.

Pivotally mounted on the frame 10 is a substantially U-shaped member 20, to one side of which is secured a cam follower 21 having a part engaging the periphery of the cam 16 and shaped to enter the recess 17. At the other end of member 20 are secured three insulating blocks 22, 23 and 24, serving to attach two contact strips 25 and 26 to the member in separated insulated condition. These contact strips 25 and 26 are provided respectively with contact members 27 and 28. A spring 29 has one end secured to the arm 21 and the other end to a stud 30 fastened to the frame 10. This spring assures intimate contact between the end of the arm or follower 21 and the cam 16. Fastened to the lower part of frame 10 is an angle member 31 having a strip of insulating material 32 secured to one surface thereof.

The contact strips 25 and 26 are biased normally to hold the contacts 27 and 28 separated, which condition prevails when the follower 21 is in engagement with the circular periphery of cam 16. In such normal position the contact strip 25 is in engagement with the insulator 32 but the contact strip 26 is spaced therefrom in the dotted line position shown in Fig. 1. How-

ever, when the follower enters the recess 17, the member 20 moves about its axis with the strip 25 being slightly flexed but still in engagement with insulator 32. Due to such movement of the member 20 the strip 26 assumes the full line position of Fig. 1, closing contacts 27 and 28.

Secured to a part 110 of frame 10 (Figs. 1 and 4) is a ring 40 made of brass or some other suitable metal. An arm 41 has a head 42 hollowed out to fit around the ring 40. The ring 40 and the head part 42 of arm 41 are of substantially the same thickness so that these parts can be held in assembly with the frame by means of a retaining ring 44, also metallic, dimensioned to overlie both the ring 40 and the head 42. By reference to Fig. 4 it will be noted that the frame part 110 has three threaded apertures 45 located in an arc about the opening 46 through which the seconds arbor 11 can pass. The rings 40 and 44 are provided with screw openings 47 and 48, respectively, three of which can be brought into register with the threaded openings 45 whereby screws may be passed through the openings 48 and 47 into engagement with the apertures 45. In this manner the rings 40 and 44 can be held rigidly or immovably relative to the frame while the arm 41 is free to rotate about the ring 40. Since all of the openings of the respective parts 40, 42 and 44 are coaxial with the opening 46 and hence with the seconds shaft 11, it follows that movement of the arm 41 will be about the axis of this seconds shaft.

Secured to the arm 41 is a substantially U-shaped member 50 to the upper leg of which are secured terminal members 51 and 52 spaced from the upper leg and from each other by insulating blocks 54. Secured to the lower leg of member 50 is a substantially Z-shaped bar 55 to the outer end of which is secured a block 56 of insulating material. Secured to the lower terminal member 52 by a leaf spring 57 is a contact strip 58 extending toward the cam 14. This strip 58 has two spaced contact members 59 thereon. Secured to the upper terminal member 51 by a leaf spring 60 is a second contact strip 61 which has a downwardly bent part and an outwardly extending part directed toward the cam 14. A pair of electrically connected spring contact members 62 are secured to the upper expanse of the contact strip 61 with their ends positioned to engage the contacts 59 on the other strip. It will be seen (Fig. 2) that the rear contact strip 58 is longer than the front contact strip 61, the difference in length being accurately determined to determine the time interval during which contacts 62 and 59 will be closed in a manner to be described later. The ends of these two strips 58 and 61 are bevelled to provide substantially sharp terminations.

Secured to the member 50 and consequently to the arm 41 is a rod 70 having two angularly disposed substantially straight expanses connected by an arc having the shaft 11 as its axis. The upper expanse of the rod 70 has its end pointed to serve as a pointer in cooperation with a scale 71 secured to the frame 10 in some suitable manner, not shown. If desired the scale 70 may be a part of the seconds dial of the clock. This scale 71 has graduations thereon of suitable number and suitably spaced for a purpose to be described later. The outer end of arm 41 is attached by suitable linkage 75 to a rod 76 mounted in guides for sliding vertical movement. The lower end of the rod 76 lies behind a slotted plate 77 and has extending therefrom a threaded member 78 pass-



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ing through a small plate 79 interposed between the rod and the rear surface of slotted member 77. A thumb nut 80 threaded onto the member 79 can be used to lock the rod 76 in any adjusted position with the confines determined by the slot of member 77.

Secured to the frame 10 in any suitable manner is a plate 85, the outer edge of which is formed on an arc having the shaft 11 as its axis. A plurality of notches 86 are provided in the outer edge of this plate, such notches being spaced apart 6° respectively. Pivotaly secured to the arm 41 is a bar 87, one end of which has a roller 88 contacting the outer edge of the plate 85 and hence the notches 86, and the other end of which has secured thereto one end of a spring 89, the other end of the spring being secured to the arm 41. This spring 89 assures good contact between the detent 88 and the edge of plate 85.

Extending between the terminals of members 25 and 52 is a conductor 90. A second conductor 91 extends from the terminal of strip 26 to a relay 92. Another conductor 93 extends from terminal 51 through a local source such as a battery 94 to the other side of relay 92. A source of impulses 95 is connected to contact 96 of the relay while the line 97 extends from the source 95. An armature 98 of the relay is connected to another line 99.

The operation of the before-described mechanism is substantially as follows. Since the cam 14 is secured to the seconds shaft 11, it follows that this cam makes one complete revolution every minute of the clock's operation. When the ends of contact strips 58 and 61 are on the circular part of the cam 11, contacts 59 and 62 are maintained in open position as shown in Fig. 1. As this cam rotates and approaches the end of a complete revolution, both contact strips 58 and 61 are elevated as they ride over the lobe 15. As soon as the shorter front contact 61 clears the sharp edge of the lobe 15, it drops from elevated to normal position, causing the contacts 62 to meet contacts 59, partially closing the circuit through relay 92. Within a predetermined time interval the longer or rear contact strip 58 likewise rides over the sharp edge of cam lobe 15 and falls to normal position breaking these contacts and restoring the circuit to normal open position. The length of the two contact strips is so calculated as to provide a suitable time interval in the nature of, for example, one and a half seconds.

The circuit through relay 92, however, is not closed at every complete revolution of cam 14 due to the contacts 62 and 59 being in series with contacts 27 and 28. These latter contacts are normally in open condition and are closed only for a predetermined time interval once every revolution of cam 16, and since this cam is on the minute shaft 12 that condition occurs once every hour. The notch 17 on cam 16 is so dimensioned that the contacts 27 and 28 are closed twenty seconds before the end of an hour of operation of the clock, and remain closed for forty seconds thereby restoring the contacts to open position at the twentieth second following the end of an hour. In this manner the control circuit having relay 92 therein is periodically conditioned.

It follows therefore that if the clock is running perfectly, i. e., is neither slow nor fast relative to a standard, the contacts controlled by cam 14 will be closed one and a half seconds prior to the end of an hour and will be opened exactly at the end of an hour. An ideal situation in so far

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as position of various contacts is shown in Fig. 1 wherein it will be seen that the arm 41 is in such position that the pointer on the end of rod 70 coincides with the median mark designated 60 on scale 71.

Under the condition just described it follows that a complete circuit through relay 92 is established one and a half seconds prior to the end of an hour. Upon completion of this circuit, armature 98 picks up, closing the circuit from the source of impulses to the lines 97 and 99, which lines lead to all satellite clocks under control of the master clock. Synchronizing impulses, therefore, are transmitted over a period of one and a half seconds operating to synchronize the mechanisms of the various satellite clocks either advancing or retarding them the necessary amount and holding such position until the end of the synchronizing impulses. When this one and a half seconds has ended and the contacts 59 and 62 are opened, the circuit through relay 92 is opened, breaking the circuit of the impulse source to lines 97 and 99 thereby removing the synchronizing action on the satellite clocks. Thus it will be seen that the necessary synchronizing impulses are transmitted once each hour, with the termination of these pulses indicating the exact end of an hour.

Should the master clock mechanism be running at a faster or slower rate than standard, an attendant would note that the synchronizing impulses are transmitted under the control of the clock either before or after the standard used for this purpose such as Naval Observatory signals or other standards. Should the master clock be running at a rate of, for example, two seconds fast, it is possible for the attendant to compensate for such fast motion by shifting the arm 41 clockwise until the pointer on the end of rod 70 is in coincidence with the second graduation on scale 71 to the right of the center or 60 mark. Such moving of the arm 41 causes a consequent movement of the contact strips 58 and 61 in an arc about the cam 14, and since this cam is rotated in clockwise direction, it follows that the closing and opening of the contacts 59 and 62 previously described will take place two seconds later than would occur under the conditions previously described. Likewise, should the clock be running at a slower than normal or standard rate, compensation may be made therefor by moving the arm 41 in a counterclockwise direction an amount sufficient to cause the pointer on rod 70 to coincide with the proper marking on dial 71. Thus, if the clock is running four seconds slow, the pointer will be moved to a position coinciding with the 56 mark on dial 71, as a result of which the contact strips 58 and 61 are moved counterclockwise relative to cam 14 thereby causing closing and opening of these contacts by the cam lobe four seconds before the normal operating point. In this manner an attendant is able to regulate the transmission of impulses in accordance with the condition of clock operation, it being understood of course that any unusual error in the operation of the clock can be regulated over a period of time in the customary manner by the addition to or subtraction of weights from the pendulum used in the clock.

In order that an attendant may be able more readily to operate this regulating mechanism, particularly in installations wherein the master clock is as usual mounted relatively high on a wall or other supporting structure, use may be made of the operating mechanism comprising the



rod 76 and the linkage 75. The screw 80 at the lower end of the rod can be located at some readily accessible height so that an attendant by merely moving the rod 76 upwardly or downwardly can move the arm 41 about the axis of shaft 11 to the desired regulatory position. For assistance in such movement and for the purpose of indicating a number representing a second of regulation use is made of the plate 85 with its notches 86 and the detent 88. An attendant can very readily note the engagement of the detent with a notch and by counting the number of such engagements can determine without actually inspecting the scale 71, the number of seconds represented by movement of the arm 41. Since these notches 86 are spaced apart angularly 6°, it follows that movement of the detent from one notch to another represents a variation of one second, either advance or retard, in the positioning of the circuit closing contacts. It should be noted, however, that the mechanism is not limited to changes of an even number of seconds but that an attendant by observation of the dial 71 can regulate the transmission of synchronizing impulses within fractions of a second. Furthermore, since the control circuit including relay 92 is conditioned once every hour for a period of forty seconds, it will be apparent that other scales similar to scale 71 of forty seconds duration can be supplied, or if the clock is normally biased to run at a relatively slow rate as is the common practice, the scale can be divided to provide a preponderance of regulation on one side of the median mark over the markings on the other side thereof.

From the foregoing it will be seen that the present invention provides novel, simple and efficient mechanism for regulating the transmission of synchronizing impulses from a master clock to its satellite clocks. It is to be understood that modifications beyond the disclosed embodiment may be made without departing from the invention, in view of which any limitations imposed thereupon are to be only those set forth in the following claims.

I claim:

1. In an impulse transmitting system, a clock, a source of impulses, a control circuit for controlling the transmission of impulses therefrom, means for conditioning said control circuit periodically for a predetermined time interval, a cam on the seconds shaft of said clock, and contacts controlled by said cam for closing the conditioned circuit for a predetermined time interval during said first time interval, said contacts being movable in unison in an arc about said seconds shaft for shifting said second time interval relative to and within said first time interval.
2. In an impulse transmitting system, a clock, a source of impulses, a control circuit for controlling the transmission of impulses therefrom, first circuit closing means in said control circuit, means for periodically closing said first circuit closing means for a predetermined time interval, a cam on the seconds shaft of said clock, an arm movable in an arc about the axis of said seconds shaft, contacts carried by said arm and controlled by said cam for closing said second circuit closing means for a predetermined time interval during said first time interval, said arm and said contacts carried thereby being movable for shifting said second time interval relative to and within said first time interval.
3. In an impulse transmitting system, a clock,

a source of impulses, a control circuit for controlling the transmission of impulses therefrom, a cam on the minute shaft of said clock, contacts controlled by said cam for periodically conditioning said circuit for a predetermined time interval, a cam on the seconds shaft of said clock, an arm movable in an arc about the axis of said seconds shaft, and contacts carried on said arm and controlled by said second cam for closing said circuit for a predetermined time interval during said first time interval, and means for moving said arm and the contacts carried thereby for shifting said second time interval relative to and within said first time interval.

4. In an impulse transmitting system, a clock, a source of impulses, a control circuit for controlling the transmission of impulses therefrom, means for conditioning said control circuit periodically for a predetermined time interval, a cam on the seconds shaft of said clock, an arm movable in an arc about the axis of said shaft, contacts carried by said arm and engaging said cam for closing the conditioned circuit for a predetermined time interval during said first time interval, and a movable member linked to said arm for moving said arm and the contacts carried thereby to shift said second time interval relative to and within said first time interval.

5. In an impulse transmitting system, a clock, a source of impulses, a control circuit therefor, means for conditioning said control circuit periodically for a predetermined time interval, a cam on the seconds shaft of said clock, an arm movable in an arc about the axis of said shaft, contacts carried by said arm and engaging said cam for closing the conditioned circuit for a predetermined time interval during said first time interval, a movable member linked to said arm for moving said arm and the contacts carried thereby to shift said second time interval relative to and within said first time interval, a plate having spaced notches in its peripheral edge, and a detent carried by said arm for engagement with said notches to position said arm in predetermined angular relations to said cam.

6. In an impulse transmitting system, a clock, a source of impulses, a control circuit for controlling the transmission of impulses therefrom, first and second circuit closing means in series in said control circuit, means for periodically closing said first circuit closing means for a predetermined time interval, an arm rotatable in an arc about the axis of the seconds shaft of said clock, means carried by said arm for closing said second circuit closing means for a predetermined time interval during said first time interval, and a sliding rod linked to said arm for rotating said arm through an arc of predetermined angularity to shift said second time interval relative to and within said first time interval.

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