J. W. BRYCE.

SYNCHRONIZING CLOCK SYSTEM.

APPLICATION FILED MAY 21, 1918.

1,310,779.

Patented July 22, 1919.

3 SHEETS—SHEET 1.

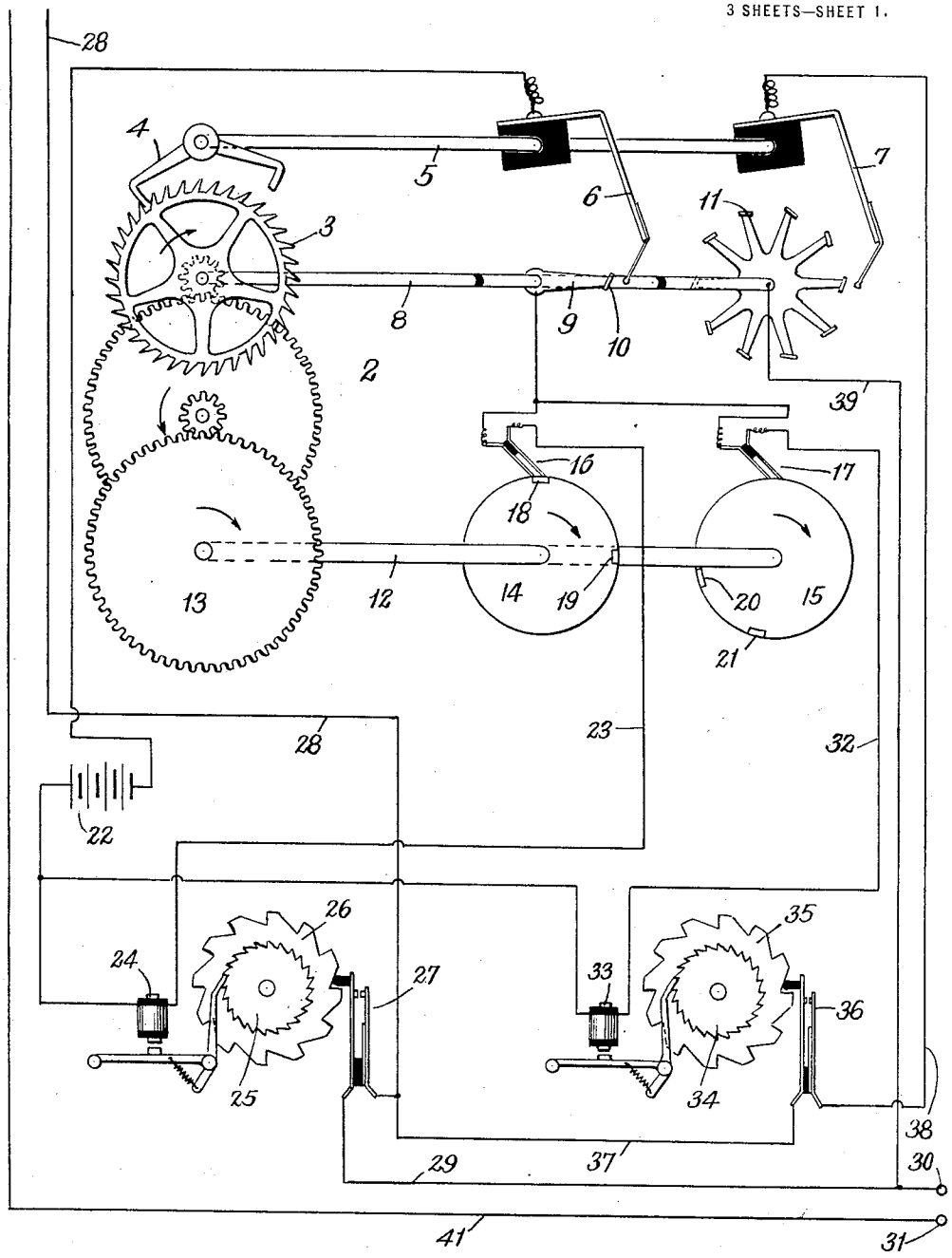


Fig. 1.

INVENTOR

James W. Bryce

BY

Kerr, Page, Cooper & Hayward

ATTORNEY

J. W. BRYCE.

SYNCHRONIZING CLOCK SYSTEM.

APPLICATION FILED MAY 21, 1918.

1,310,779.

Patented July 22, 1919.

3 SHEETS—SHEET 2.

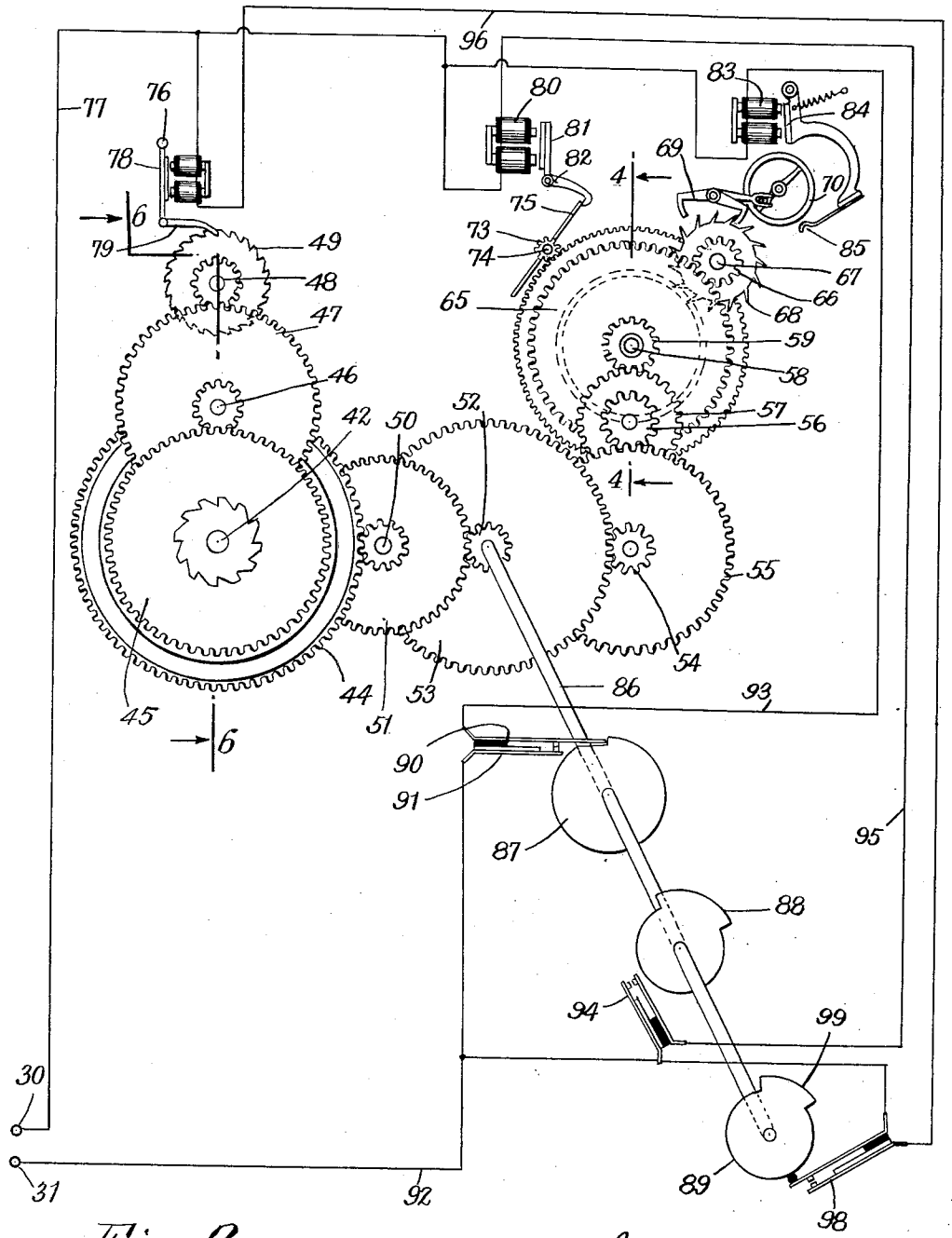


Fig. 2.

James W. Bryce
INVENTOR

BY

Kerr, Page, Cooper & Hayward
ATTORNEY

J. W. BRYCE.

SYNCHRONIZING CLOCK SYSTEM.

APPLICATION FILED MAY 21, 1918.

1,310,779.

Patented July 22, 1919.

3 SHEETS—SHEET 3.

Fig. 3.

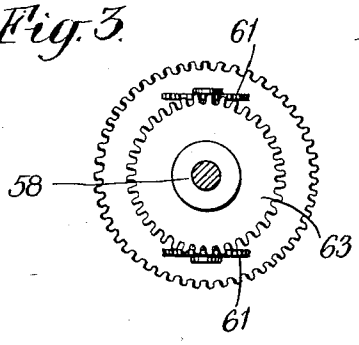


Fig. 4.

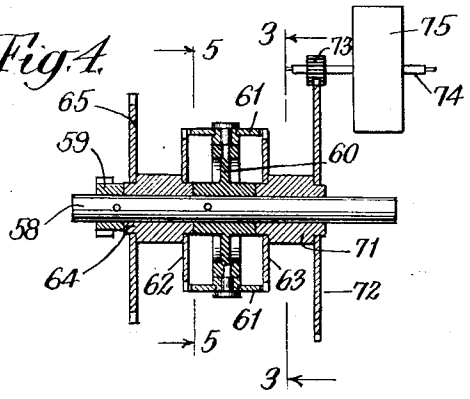


Fig. 5.

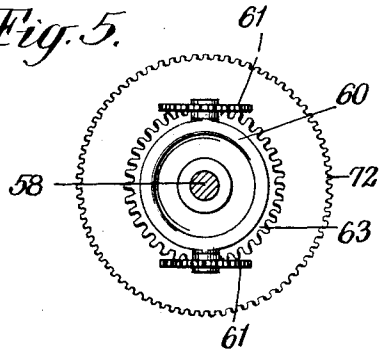


Fig. 6.

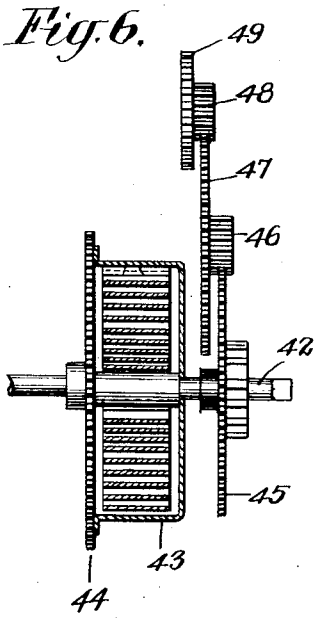
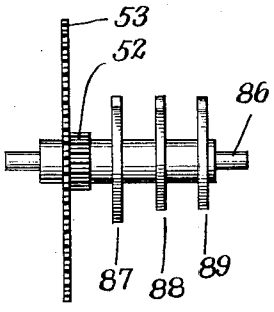


Fig. 7.



INVENTOR

James W. Bryce

BY

Kerr, Page, Cooper & Hayward

ATTORNEY

UNITED STATES PATENT OFFICE.

JAMES W. BRYCE, OF BINGHAMTON, NEW YORK, ASSIGNOR TO INTERNATIONAL TIME RECORDING COMPANY OF NEW YORK, A CORPORATION OF NEW YORK.

SYNCHRONIZING CLOCK SYSTEM.

1,310,779. Specification of Letters Patent. Patented July 22, 1919.

Application filed May 21, 1918. Serial No. 235,813.

To all whom it may concern:

Be it known that I, JAMES W. BRYCE, a citizen of the United States, residing at Binghamton, county of Broome, State of New York, have invented certain new and useful Improvements in Synchronizing Clock Systems, of which the following is a full, clear, and exact description.

The invention, subject of this application, is primarily an improvement in electrically controlled clock systems adapted to be run by current derived from ordinary municipal power or lighting or other industrial circuits, and more specifically relates to time-recording systems in which the controlled clock mechanisms are employed to operate time-recording or similar devices. The nature and purpose of the improvements may be most readily comprehended by a brief recital of the conditions which it is designed to meet and the objections which it is proposed to overcome.

It is well known that no ordinary circuit of the character above referred to can be depended upon to furnish an absolutely continuous flow of current. Interruptions in such flow are practically certain to occur, due to the blowing out of fuses, the shifting of switches at the power house, or other sources, or on branch lines or distributing centers and to other causes, but in all electric impulse systems in use at the present time, that is to say systems which involve short current impulses such as are transmitted by a master to a series of secondary clocks, it is commercially impracticable to operate by any other means than by a primary or storage battery for furnishing the current, as there are at least 1440 impulses transmitted per day, and the omission of one throws the whole system out of step with the master clock, and this destroys synchronism.

The system upon which this application is designed to operate at all times on ordinary industrial circuits with substantially theoretical accuracy regardless of such possible and even probable interruptions of current therein, and the accomplishment of this purpose is of very great practical and commercial importance, for while, on the face of things, it would seem extremely simple to employ a storage battery for the electromagnets of the controlled clocks or clock mechanisms, the expense of maintenance, the necessity for skilled labor in the management of the system and the problems involved in the wiring therefor, present reasons against its adoption which in many cases are conclusive.

The primary object of the invention is to provide a system in which the secondary clocks may be brought to or maintained in substantially perfect synchronism with the master clock, without regard, within limits, to their condition, that is to say, whether they be initially out of step with the master clock, or whether they be brought so by any cause, including the cessation of the controlling or operating current for prolonged periods, as for example, if such current be shut off from Saturday noon to Tuesday morning, as may happen when Monday is a holiday. The invention further provides for the operation of the system by either direct or alternating currents and the synchronizing means are so organized that even abnormal departures from synchronism are readily and quickly corrected.

In carrying out the objects above recited I have developed a system which secures numerous other and secondary advantages, for instance, the secondary clocks may be put into operation even before the wiring for the system has been installed, or any clock mechanism may be removed from the system and used independently should the need for so doing arise, and owing to the fact that the units are interchangeable, the cost of manufacture and the degree of skill required in the maintenance of the system is very greatly reduced. Finally, the wiring is greatly simplified and the number of breaks between separating contact points necessary in such systems is reduced to a minimum and, hence, the cost of installation and repair or maintenance is extremely low.

I have illustrated the means which I have devised for these purposes in the accompanying drawings.

Figure 1 is a diagrammatic illustration of the more essential elements and the circuit connections of a master clock of usual or known construction, but shown as necessary to a full understanding of the improvements which I have made in the system as a whole.

Fig. 2 is a similar view of the controlled clock mechanism and its wiring which embodies the novel features of my invention.

Fig. 3 is a detail section of a differential gear forming a part of said mechanism and taken on line 3—3 of Fig. 4.

Fig. 4 is a cross-section of the same on the line 4—4 of Fig. 2.

Fig. 5 is a section on the line 5—5 of Fig. 4.

Fig. 6 is a section of the clock driving or winding mechanism on line 6—6 of Fig. 2.

Fig. 7 is a detail side view of the hour shaft of the clock mechanism showing three cams used for controlling the same.

Except in such particulars as may be hereinafter noted and defined by the more specific claims, the construction of the various parts or elements of the apparatus is not of the essence of the invention, as these may be very greatly varied. This will be made more fully to appear from the context.

To gain preliminarily a clear understanding of the nature and the functions of the master clock, reference may be had to Fig. 1. The numeral 2 indicates the clock train of such a mechanism, the driving means not being shown, as they are well known. The numeral 3 indicates the escape wheel of such a clock, assumed to have a sixty-beat rate; 4 is the verge and 5 the shaft on which it is mounted, and 6 and 7 are contact fingers carried by this shaft.

The shaft of the escape wheel, diagrammatically shown, is marked 8, and carries an arm 9 with an inclined contact 10 at its end with which the finger 6 makes wiping contact once every minute. The shaft also carries a wheel 11 with a plurality of teeth, ten being a convenient number, each tooth having a similar end contact plate with which finger 7 makes wiping contacts and at the rate of ten per minute.

Finally the shaft 12 of the wheel 13 which revolves once an hour carries two disks 14 and 15 upon the peripheries of which slide double contacts 16 and 17. In the disk 14 are set two conducting segments 19 and 18, the first of which comes under contacts 16 a given number of minutes, say fifteen, before the hour and the other 18 under the same contacts at the even hour. Similarly disk 15 has two conducting segments 20 and 21, the first of which comes under contacts 17 at say seventeen minutes after the hour and the other say twenty-seven minutes after the hour.

The verge shaft 5 oscillating sixty times in a minute, as above stated, closes contact with the arm 9 once each minute and this completes a circuit which for simplicity's sake we have shown as running from a local battery 22, to one of the contacts 16, and as these contacts at that moment may be assumed to be on the segment 19 the circuit is continued through wire 23, back to the battery 22 through an electromagnet 24.

An energizing impulse through this magnet operates to move a ratchet wheel 25, which in turn moves a larger ratchet wheel 26 one tooth and brings the high point of a tooth under one of two normally separated contacts 27, resulting in the completion of a circuit from wire 28 connected with or constituting the main operative circuit, to wire 29 and line terminal 30, to the secondary clocks, from which the path back is to the common return terminal 31 and wire 41.

The ratchets 25 and 26 remain in the condition to complete this circuit until, by the movement of the hour shaft 12, the contact 18 is brought fifteen minutes later or at the even hour under contacts 16. Thereupon the ratchets are moved to permit the contacts 27 to again separate, and to break the circuit to line. But then, after the lapse of seventeen minutes, the segment 20 is brought under contacts 17, whereupon the circuit of the battery 22 is closed by wire 32 to an electromagnet 33, which operates ratchet wheels 34 and 35, similar to those above described and closes the two contacts 36, which connect the main 28 and wire 37 with wire 38 to the finger 7 so that each time the latter wipes one of the ten teeth of wheel 11 a line impulse is sent thereby through a wire 39 to line terminal 30 through the common return terminal 31 and wire 41.

The above described operation of the master clock continues at all times whether there be any current in the main line or not, and its effects will be understood from the description of the secondary clocks which now follow.

The construction of the secondary clock, except in the respects hereinafter pointed out, is or may be such as is ordinarily employed for driving recording mechanisms. In the main, each comprises a shaft 42 on which the main spring is mounted (Figs. 2 and 6), one end of such spring being connected to said shaft and the other two to the drum 43 and gear wheel 44. Mounted fast on the shaft 42 is the gear 45, which with pinion 46, gear 47, pinion 48 and ratchet 49 constitute the winding train of the clock mechanism.

In mesh with gear 44 is the usual clock train driven thereby and comprising the pinion 50, the gear 51, the pinion 52, the gear 53, the pinion 54, the gear 55, the pinion 56 and the gear 57. A shaft 58, however, carries a differential gear which is peculiar to this device and is a feature of novel construction and function therein.

On shaft 58 is mounted fast a pinion 59 (Figs. 2 and 4), and this meshes with the gear 57 of the clock train. On the same

shaft is also mounted a bar or arm 60 in the opposite ends of which are set the floating differential gears 61. It will be understood that while two such gears 61 are shown one only need be used if so desired. These gears mesh with the gears 62 and 63 at right angles thereto, the former of which is fast on a hub 64, loose on the shaft 58, and carrying a gear 65 fast thereto which meshes with a pinion 66 on a shaft 67 of the escape wheel 68.

The escape wheel 68 has a verge 69 coöperating with it and a balance wheel 70 the main spring of which is not shown in the drawing, but these parts are of the ordinary and well known construction.

The second gear wheel 63 is mounted on a hub 71 loose on shaft 58, which has a gear wheel 72 secured to its end, said gear wheel meshing with a pinion 73 mounted on a spindle 74 carrying a fan 75.

In addition to the purely mechanical parts above described the following electrical elements complete the organization of the clock mechanism. A magnet 76 connected with wire 77 from the binding post 30 operates an armature 78 carrying a pawl 79 and when an impulse of current energizes the said magnet the ratchet wheel 49 is moved one step so that a succession of impulses through the magnet will wind up the clock.

Connected with the same circuit is also a magnet 80 operating an armature 81 carrying a pawl 82 which, when the magnet is energized, is withdrawn from engagement with the fan 75 and leaves it free to rotate, and the clock spring to unwind with relative rapidity and the clock to be advanced at a corresponding rate.

Again, a magnet 83, also connected with the circuit of wire 77, operates an armature 84 which carries at its end a brake shoe 85 which, when the magnet is energized, presses against the balance wheel 70 and stops the same, and which, upon the demagnetization of the said magnet, slides off from the periphery of the wheel and gives it a slight impulse to start it immediately in motion again.

The operation of the system is as follows: The shaft 86 of the pinion 52 rotates once an hour and this shaft carries three cams, 87, 88 and 89. Cam 87 may be designated as the retarding cam for it has a cut-away portion which permits a contact 90 that slides over its periphery to drop when it meets the cut-away part into engagement with a second contact 91 and closes a circuit from binding post 31 through wires 92 and 93 to and through the electromagnet 83 that stops the clock movement. Cam 88 may be termed the accelerating cam for it has a raised portion which, at a certain moment raises one of a pair of contacts 94 into engagement with the other, and thereby completes the circuit from binding post 31 through wire 95 to and through the magnet 80 that releases the fan 75 and permits the clock mechanism to run ahead.

It will be recalled that in the description of the master clock it was shown that at fifteen minutes before the hour by the conjoint action of the finger 6, the conducting segments in the disk 14 and the magnet 24 the main current was sent to line through binding post 30 for fifteen minutes or until the even hour segment 18 in disk 14 operated to interrupt this flow of current. If, therefore, the secondary clock mechanism is exactly on time at the hour, and the contacts 90 and 91 come into engagement at the moment when the current to binding post 30 is interrupted by the master clock, no current will flow through magnet 83 and the clock mechanism will not be stopped. So also if the secondary clock be slow, the contacts 90 and 91 will not have dropped into the cut-away part of the disk 87 until after the master clock has interrupted the circuit to magnet 83.

On the other hand, assume that before the master clock interrupts this circuit on the even hour the secondary clock is fast, then the circuit through magnet 83 will be closed and the secondary stopped until the master clock has caught up with it.

Out of abundant precaution this may be illustrated by an example. Assume the secondary clock to be eight minutes fast or ahead of the master clock, then its cam 87 will permit the contacts 90 and 91 to come in contact at the instant when it reaches the even hour position of its own hands, and the circuit through magnet 83, which is closed by the master clock fifteen minutes before the hour, will keep the balance wheel stationary until the master clock reaches the true hour position and breaks the circuit of magnet 83.

Synchronism is thus established but it will be observed that the means that have brought this about are operative only when the secondary is too fast, or in other words that they constitute only a retarding means; another means for synchronizing, when the secondary is slow is therefore required.

Cam 88 has high and low parts of the periphery the high part of which brings contacts 94 together and the low part allows them to separate. The parts are so arranged that the contacts are brought together at about thirty minutes after the hour as shown by the hands of the secondary clock and separated at exactly fifteen minutes of the hour.

Now, if the master clock sends current to binding post 30 from exactly fifteen minutes of the hour to the even hour, the secondary clock, if in exact time, will separate the con-

tacts 94 at the instant when the master clock throws on the current and nothing will happen. So also, if the secondary clock is fast, the contacts 94 will have separated before the master clock current is established and nothing will happen. If the clock be slow, however, the circuit will be closed through contacts 94 and magnet 80 and the fan mechanism will be released and the secondary clock will rapidly advance because nothing but the freely revolving fan resists the unwinding of the clock.

The escapement 69 controls the unwinding of the clock through its connection with the train through one side of the differential. The same train through the other side of the differential is connected with the fan, and is normally locked until the fan is released, whereupon it immediately rotates at a relatively rapid rate and this movement brings the clock hands up to synchronism to a position where it indicates fifteen minutes of the hour before the contacts drop off the raised part of the cam and separate. The secondary will then agree with the master clock.

It requires but a very brief time to accomplish this and, while it is not theoretically perfect synchronism, the interval is such a minute fraction of a minute that it is of no commercial importance. If so desired, the secondary may be made to synchronize a trifle fast, and be corrected and set in true synchronism at the hour position. It is not thought necessary, in view of the above, to give a specific example to illustrate the action occurring when synchronizing for slowness.

It has been explained that at seventeen minutes after the hour the circuit from the main line was closed for ten minutes through the contacts 36 to the finger 7. For ten minutes during each hour therefore the finger 7 will send through the teeth of wheel 11 momentary impulses of current to the binding post 30, to the secondary clock. These impulses received by the corresponding terminal 30 of the secondary clock pass through the wire 77, the electromagnet 76 and wire 96, to the normally separated contacts 98 which, when closed by a projection 99 on cam 89, for a corresponding interval of ten minutes complete the circuit to the common return. The magnet 76 will therefore during each hour receive 100 impulses, each one of which is designed to wind the spring of the secondary clock an amount sufficient to run it for two minutes, which is more, under normal circumstances, than enough to keep it fully wound up. This is so that the clock may make up any loss of winding it may have suffered at some previous hour or hours when the current may have been shut off.

From the above description the advantages of my system will be manifest. Assume for example that the secondary clocks are of the eight day type. While current is furnished they will be kept fully wound up, so that, if the current be interrupted even for several days, the system will continue to run, and as soon as current starts to flow again the whole system is brought rapidly into nearly theoretically perfect operative condition again.

The construction of the parts or elements of the system, as I have previously stated, are not material. For practical purposes I have shown what I regard as the best, but the invention is not limited to these forms. For example, any device may be used in place of the differential gear described that will perform the same function or secure the same result. Again, it is not essential to the operation of the system that winding impulses be transmitted, as it is obvious that these are effective only in case a ratchet winding device be employed, but other means of winding are not herein illustrated, as they will be made the subject of other applications. Finally, the use of a single circuit for both the winding and synchronizing operations is not necessary, as special circuits for these purposes may be employed, if so desired.

The essential features of my invention are that means be provided for running the system without regard to interruptions in the main current supply, and to provide the clocks with devices whereby they may run ahead at certain intervals and be retarded at others, all to be controlled by the relative positions of certain elements of the secondary clocks as compared with some element in the master clock at definite and predetermined intervals of time.

In practice the arrangement of contacts is such as to provide for errors or departures from synchronism far greater than would ordinarily be likely to occur. But this will be understood as a mere safeguard or matter of convenience unattended with any disadvantages. The time intervals, for example, for closing the circuit are not only arbitrarily fixed in duration but they may occur at other parts of the hour or more or less frequently. These are matters, however, that those skilled in the art will readily understand.

What I claim is:—

1. In a system of the kind described, the combination with a line circuit, a master clock and one or more secondary clocks connected therewith, of means in the master clock for connecting to the line circuit a source of current at predetermined intervals of substantial and definite duration, means in each secondary clock for retarding and means for accelerating its rate, and means operative at definite and predetermined in-

tervals, as indicated by the hand of the secondary, for bringing said means into operative relation with the main line, whereby the retarding means, during the periods of overlapping of said intervals, will be repeatedly operated, if the clock be too fast, or the accelerating means, if the clock be too slow, until said clock is brought into accord or synchronism with the master clock.

2. In a system of the kind described, the combination with a line circuit, a master clock, and one or more secondary clocks connected therewith, of means in each secondary clock for retarding and means for accelerating its rate, and means for continuously and repeatedly operating, under the joint control of the master and secondary clock, either of said means during such periods as the controlling action of the secondary clock may be exercised at the same time as that of the master clock, whereby said secondary clock during such periods will be retarded if too fast or accelerated if too slow, until brought into synchronism with the master clock.

3. In a system of the kind described, the combination with a master clock and one or more secondary clocks, of means controlled by the master clock for connecting the line circuit to a source of current at predetermined prolonged intervals of given duration, devices in the secondary clocks for retarding and other devices for accelerating their rate, and means for connecting said devices respectively in operative relation to the line for definite intervals with reference to the time as indicated by the hands of the said secondaries, so that one or the other may be repeatedly operated during the periods of overlapping of said intervals, according to whether the secondary clock be too fast or too slow, until said clocks are brought into accord or synchronism with the master clock.

4. In a system of the kind described the combination with a master clock and one or more secondary clocks of means controlled by the master clock for connecting a line circuit at predetermined intervals of given duration with a source of current, devices in the secondary clocks for checking the movement and other devices for accelerating such movement, and means for connecting said devices respectively with the line circuit during intervals of given duration timed in such relation to the intervals of connection of the line to the source of current by the master clock that when such intervals overlap the secondary clock will be brought during said overlapping periods into synchronism with the master clock.

5. In a system of the kind described the combination with a master clock and one or more secondary clocks, means controlled by the master clock for connecting a line circuit with a source of current for a definite period during each hour, a device in each secondary clock for stopping its movement and another device for accelerating its movement, and means controlled by the movement of the secondary clock for connecting the stopping device with the circuit at or near the end of the period of connection thereof with the source by the master clock, and means for connecting the accelerating device with the circuit at or near the beginning of such period whereby if the periods of closure in the two clocks overlap the secondary clock will during such periods of overlapping be stopped or accelerated until brought into synchronism with the master clock.

6. In a system of the kind described, the combination of a line, a master clock and secondary clocks controlled thereby, means in the master clock for connecting to the line at definite intervals a source of current, means for bringing, when operated, the secondary clocks into synchronism with the master clock, said means comprising a device for stopping and mechanism for accelerating the rate of each secondary clock, and means for connecting the same with the line at predetermined intervals as indicated by the hands of the secondary clocks, whereby one or the other will be operated during the periods of overlapping of such intervals should such overlapping occur, or neither will be operated if it does not occur, according to whether the secondary clock be too fast, too slow or on time, until the secondary clock which is out of true time is brought into synchronism with the master clock.

7. The synchronizing clock system herein described, comprising in combination means in the master clock and coöperative means in the second clock for establishing for definite and prolonged intervals electrical relations in the secondary clocks which, during such periods as said intervals may overlap, will retard the secondary clocks if they be too fast or accelerate their rate if they be too slow, until such clocks are brought into synchronism with the master clock.

In testimony whereof I affix my signature.

JAMES W. BRYCE.