(No Model.)

2 Sheets—Sheet 1.

E. P. WARNER.

INDIVIDUAL ELECTRIC SIGNAL.

No. 339,718. Patented Apr. 13, 1886.

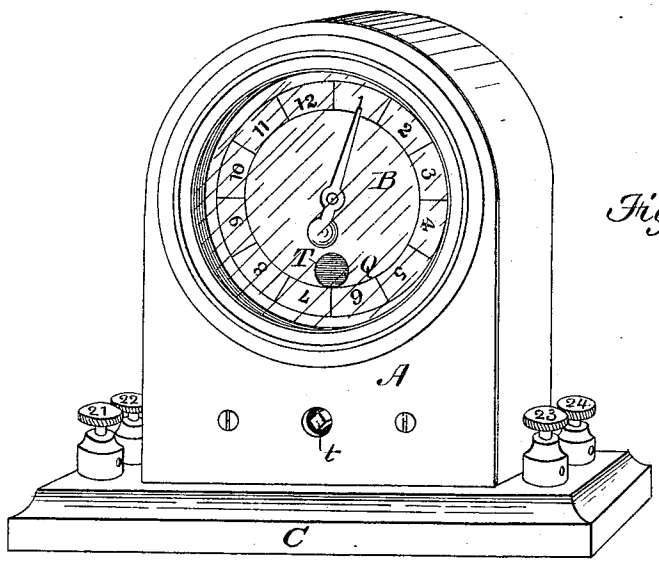

Fig. 1.

Fig. 2.

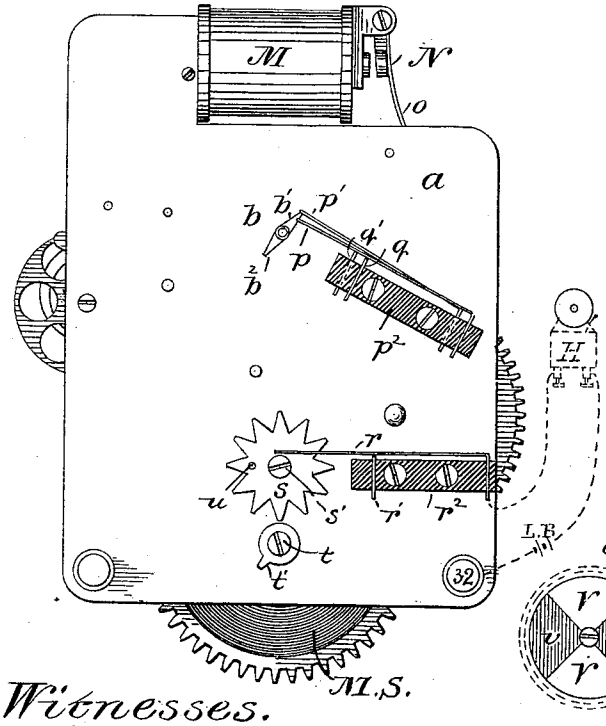

Fig. 3.

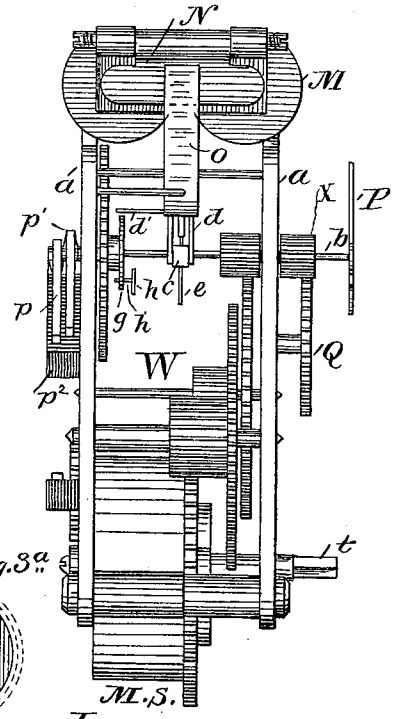

Fig. 3a.

Witnesses.

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Ernest P. Warner,

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George P. Barton

(No Model.)

2 Sheets—Sheet 2.

E. P. WARNER.

INDIVIDUAL ELECTRIC SIGNAL.

No. 339,718. Patented Apr. 13, 1886.

Fig. 4.

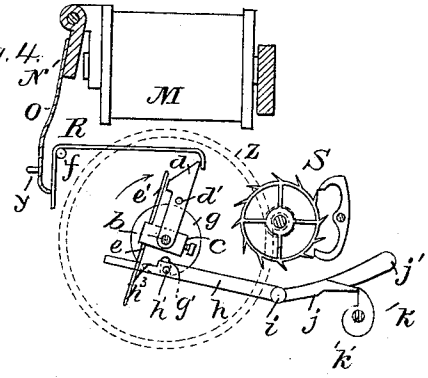


Fig. 5.

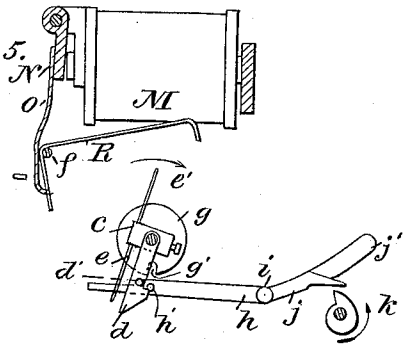


Fig. 6.

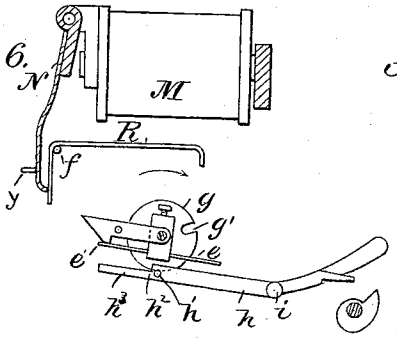


Fig. 7.

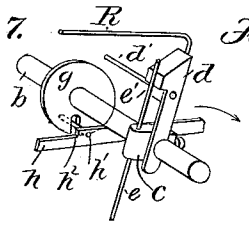


Fig. 8.

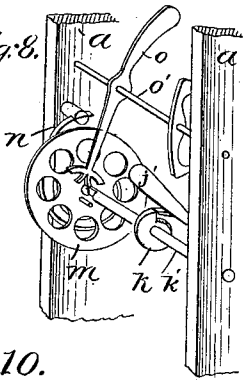


Fig. 9.

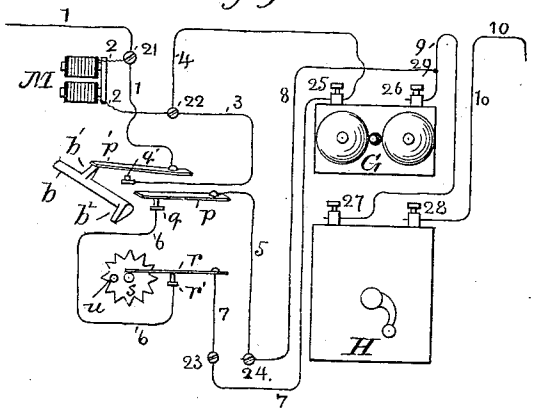
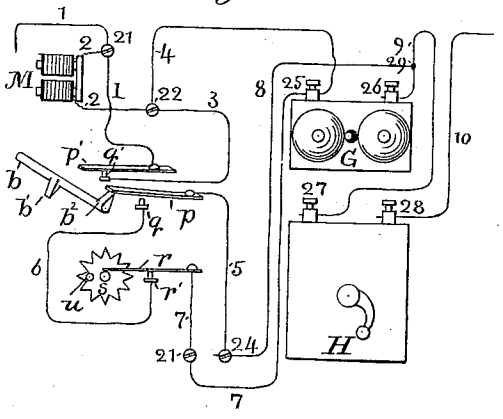


Fig. 10.



Witnesses.

Henry Trunkfuller,

F. H. McCulloch.

Inventor,

Ernest P. Warner,

by his Attorney,

George P. Barton

UNITED STATES PATENT OFFICE.

ERNEST P. WARNER, OF CHICAGO, ILLINOIS, ASSIGNOR TO THE WESTERN ELECTRIC COMPANY, OF SAME PLACE.

INDIVIDUAL ELECTRIC SIGNAL.

SPECIFICATION forming part of Letters Patent No. 339,718, dated April 13, 1886.

Application filed March 13, 1885. Serial No. 158,767. (No model.)

To all whom it may concern:

Be it known that I, ERNEST P. WARNER, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a certain new and useful Improvement in Individual Electric Signals, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

My invention relates to that class of individual electric signals in which the several signal-bells included in or upon an electric circuit have their actuating electro-magnets normally shunted, and are each controlled by normally-quiescent clock-trains, which, when a signal is to be transmitted, can be simultaneously set in motion, and which thereupon successively introduce the signal-bell magnets into the circuit for a short and definite space of time, during which and at no other time the alarm can be sounded upon the bell.

Heretofore and prior to my invention it has been customary to operate individual signals controlled by clock-trains in various ways—for example, Letters Patent issued to George H. Bliss, January 13, 1880, and numbered 223,469, show signal-bells connected serially in an electric circuit, and having their armatures mechanically controlled by clock-trains which at all times are in operation, and which release each armature at a different time from the others for a short period, during which the signal may be given.

Letters Patent issued to George H. Bliss, March 9, 1880, and numbered 225,327, describe, in addition to the foregoing instrumentalities, a shunt-circuit normally surrounding each bell-magnet, said shunt being automatically broken by the clock-work at each bell during the time that the armature of said bell is released.

Letters Patent issued to Francis Blake, Jr., September 21, 1880, numbered 232,442, show and describe a series of signal-bells in a line-circuit, each normally shunted from the circuit and each shunt controlled by a normally-quiescent clock-train, and adapted by suitable mechanism connected with said clock-train to be opened, so as to include each bell successively into the circuit, combined with an automatic transmitter at a central station capable of being set to correspond with any one of the signaling-bells, so that while all of the clocks were set in motion at each signal, only the station corresponding with the transmitting device would be signaled. This patent was subsequently reissued, June 7, 1881, as No. 9,749.

Letters Patent issued to George H. Bliss, May 24, 1881, No. 241,914, in addition to a series of electric bells normally shunted from the main circuit and clock-trains to break said shunts, show and describe a separate and normally-open shunt-circuit adapted to be closed around the starting-magnets immediately after the function of said magnet is subserved, and to be automatically reopened as soon as one revolution of the clock is completed.

Letters Patent issued to Theo. N. Vail, September 6, 1881, No. 246,696, show and claim a clock-movement having a stop mechanism which is arranged to stop the oscillating governing portion of the escapement at or near the end of its oscillating movement with the hair-spring in tension, so that when released it is at once ready again to oscillate.

I understand that the patents which I have thus cited and briefly described represent the state of the art prior to my invention.

Instrumentalities based upon the combined inventions described in the foregoing patents have some time been in use and have become commercially known as "Bliss-Blake," or, more briefly, as "Bliss," clocks. They have, however, developed certain defects in practical operation, which, by my invention, I aim to overcome. These instruments as heretofore constructed have invariably been maintained in a normally-quiescent condition by means of various kinds of detents or catches, upon which to set the clocks in motion, the starting electro-magnets have been required to act directly. The successful operation of the starting device has thus depended altogether upon the strength or power capable of being exercised by the electro-magnet. This has rendered the use of very light and delicate clock-trains a necessity as the attractive power of an ordinary electro-magnet is obviously insufficient

to safely control trains of great power and mechanical moment, while it is equally manifest that it is inconvenient to employ starting electro-magnets sufficiently large and powerful to control in a direct manner clock-trains capable of doing the work of circuit-changing with trustworthiness and precision. It has, moreover, been found undesirable in practice to employ a powerful current of electricity upon the lines to energize the starting-magnets, and it is an obvious advantage if the same small magneto-generator universally employed to ring the bells can likewise be used to energize the starting-magnet.

In consequence of the conditions which I have stated the clocks which have heretofore been used frequently fail to start when desired, the electro-magnet not acquiring sufficient attractive power with the current employed to exercise its releasing function, and on other occasions when a clock has duly started it fails to properly effectuate the circuit-changing operation and stops prematurely before completing its revolution, it being understood that the clocks employed in this class of signaling make but a single revolution of their operating-arbor at one trip, stopping thereafter at a common unison-point.

One of the objects of my invention is to provide a circuit-controlling clock having an extremely powerful train and motive power, the starting mechanism of which shall not be dependent upon the power of the starting electro-magnets directly exerted, whereby, while I may employ a clock-train of extra power, I am enabled also to employ a starting-magnet therefor of but ordinary size and strength, and to energize the same by a comparatively feeble current.

One part of my invention consists of the swinging weight or shutter which is raised by the clock-train during each revolution to a point where it is supported as long as the starting-magnet remains unenergized, the superfluous energy of the said motor being thus stored as potential energy, while the weight remains elevated. The entire work of the electro-magnet consists solely in withdrawing the support from this swinging weight, which then falls forward upon the detent of the clock-train, releasing said detent and permitting the clock to start. It will readily be observed that although considerable force is required to release a strong train, the said force is at first stored by the train itself in raising the weight, this being ultimately utilized in the fall of said weight, the momentum and power being greatly amplified by the height from which it falls; or, in other words, its potential energy is made kinetic and does work in the transformation.

Another defect heretofore existing in station-signaling apparatus, depending for its success upon the proper operation of clock-trains, is the fact that the said clocks, whether actuated by weight or spring, would, if permitted to run down, render the entire signaling mechanism inoperative, inasmuch as no way would be afforded to break or open the normally-existing shunt-circuit surrounding the helices of the bell-magnet, and the said signal-bell consequently could be operated no more until the fact that the clock had run down could be ascertained and remedied by rewinding. To prevent the occurrence of such mischances is another of the objects of my present invention; and I attain this end by providing an automatic winding-alarm so arranged that when the clock requires winding, and immediately before it has totally run down, the subscriber's bell will be placed in the line-circuit, when it will of course respond and give the alarm, not only when its own station is called, but also in response to any call-signals sent over the line to any station whatsoever. The attention of the subscriber is thus called to the fact that the clock requires winding and that operation is thereupon promptly performed. The said alarm mechanism comprises an additional spring-circuit changer in the bell-magnet shunt-circuit, which circuit-changer is placed in the path of and adapted to be engaged by a toothed or star wheel, or by a pin attached thereto after the said wheel has advanced to a certain fixed point in its orbit. This wheel being engaged and driven by a second wheel or cam placed on the main or spring shaft or arbor, the several elements are so arranged that the spring-circuit changer is lifted by the wheel and adapted to engage therewith before the energy of the motive power is exhausted, and the shunt-circuit is thus broken and the bell-magnet introduced into the main circuit for the time being. When the clock is wound up, the wheel on the spring-shaft is restored to its original position, ready to resume its function.

My invention furthermore consists in certain details of construction and arrangement, which will hereinafter be more specifically pointed out in the claims.

In the drawings, which illustrate this invention, Figure 1 is a perspective view of the clock-circuit-changing instrument. Fig. 2 is a rear elevation of one side thereof, the cover being removed. Fig. 3 is an end elevation, disclosing the operative mechanism. Fig. 4 is a detail showing the normal arrangement of the starting mechanism. Fig. 5 is a detail showing the position of the same parts at the moment the detent is tripped and the train started. Fig. 6 shows the same parts when the current is withdrawn from the electro-magnet and the revolution nearly completed. Fig. 7 shows in perspective the position of the releasing-weight and detaining-gear when at rest. Fig. 8 is a detail in perspective showing a portion of the governing-escapement and balance-wheel. Fig. 9 is a diagram illustrating the normal circuit arrangement at a given station, the alarm-bell magnet being shunted and the starting-magnet in the main circuit.

Fig. 10 is a diagram representing the circuit arrangement at a given station when the alarm is in operation, the bell-magnet being brought into circuit and the starting-magnet shunted out of the circuit.

At each station on a telephone-circuit the alarm is normally shunted from the main line, a clock-train, W, being provided controlled by an electro-magnet, M, the electro-magnets at all stations being normally included in the circuit. The office of the clock-trains (which are normally inert) is, when started by the impulse of a current sent from any station flowing through the starting-magnets, to first close a shunt-circuit round all of the said starting-magnets, which shunt-circuit is maintained until the clocks come nearly to rest at the end of the revolution; and, secondly, to break successively the shunt-circuits round the signal-bells, so that any station, by watching a pointer, P, which rotates round the dial B of its own instrument, can tell which bell at any instant is in circuit, and by sending signals at that moment will sound an alarm upon the bell responding to the figure indicated, and upon no other.

I will first describe the arrangement of circuits at several stations, referring to the diagrams, Figs. 9 and 10. Fig. 9 represents the arrangement of the signaling-circuits at each station when at rest. The main line, entering at 7, is attached to the apparatus at the screw-terminal 21, where it divides, one branch leading by the wire 1 to the circuit-changing spring p', where it remains open or insulated as long as the apparatus is inert. The other branch leads through the starting-magnet M by wires 2, and then passes to the screw terminal 22, where the line is again divided, one branch passing by wire 3 to the circuit-changing point q', where it remains insulated, while the other branch wire, 4, leads to one of the screw terminals, 25, of the bell G. The main line then continues through the magnet-coils of said bell G to the terminal screw 26, and by wire 9 to the generator H, entering the same by screw 27 and leaving by screw 28, thence to wire 10, and outward to the next station. It will be observed that the alarm-bell G is shunted or short-circuited by a loop connected on one side with the binding-screw 25 and on the other with the binding-screw 26, and passing between the said points by wire 7 to screw 23, circuit-changing spring r, point r', wire 6, contact-point q, circuit-changing spring p^2, wire 5, screw 24, wire 8, and junction-point 29. A shaft, b, having cams b' and b^2, is actuated by the clock-work to operate the circuit-changing springs p and p'. The circuit-changer p' controls a shunt-circuit round the starting-magnet M. At each station the cams b' are attached to the same point on the shaft b, while the cams b^2 differ in position for each station. When the generator H at any station is operated, the magnets M at all the stations are energized, and through the intermediation of suitable mechanism, to be hereinafter described, clock-work is released, actuating the cam-shaft b. In the revolution of said shaft the cam b' is immediately withdrawn from spring p', and said spring consequently falls upon the point q', thus completing the shunt-circuit round the starting-magnet *via* wires 1 and 3, spring p', and contact-point q'. As the revolution of the shaft continues, the cams b^2 successively lift the spring p from their points q, thus introducing the several bell-magnets G successively into the main line by breaking the shunt round them, as shown in the diagram, Fig. 10, which represents the circuit arrangement of a single station at the time when its bell may be rung. The starting-magnets remain shunted until the revolution of the shaft is nearly completed, when the cams b' return and lift the springs p' into their normal positions.

The only difference between the several arrangements of Figs. 9 and 10 are those which I have described. The springs p and p', together with their contact-points, are mounted on an insulating-block, p^2. A circuit-changer, $r\,r'$, is shown in the bell-magnet shunt-circuit, the function of which I shall hereinafter describe. The circuit-changers to be efficient must bear upon their contact-points with power, and must themselves be rather stiff. It will now be understood that if the circuit-changing function of the clock-movement is to be efficiently and reliably performed, the said movement requires a motor of considerable power or strength, in order that the varying strains imposed thereon may be successfully met. I accordingly employ clock-work W of great strength, and a mainspring, M S, of corresponding power, a power, in fact, much greater than the work to be done actually requires. The clock-work is of course governed through the spur-wheel z, (shown in dotted lines in Fig. 4,) and a pinion on the escapement-wheel axis by a balance-wheel, m, escapement-lever o, oscillating on the arbor o', and escapement S, in a manner well understood. A weight may, however, be substituted for the mainspring, if desired. The motor may be wound when required by means of the winding-shaft t.

Referring to Fig. 3, it will be seen that the mainspring drives a suitable train, which, when in motion, rotates the operating-shaft b, which carries on its front end the pointer P, and its other end the cams b' and b^2, which operate the circuit-changing springs, as already described.

The stop mechanism of the clock is constructed as follows, as shown in Figs. 3, 4, 5, 6, 7, and 8. On one of the arbors, preferably the arbor b, carrying the cams and pointer, is fixed a disk, g, having a notch, g', cut in its edge, while on the balance-wheel arbor k' is a hook or catch, k. This hook is so set upon the balance-wheel arbor or shaft k' that it holds the hair-spring in tension on one side of the

center of oscillation whenever it is engaged by the detent *j*. A stop-lever, *h*, is pivoted to the frame *a* at *i*, and has, near the end of its longer arm, a pin, *h'*, projecting at right angles therefrom. This pin *h'* rests lightly against the edge of the disk *g* until the notch *g'* allows the pin to move upward. The pin *h'*, provided upon the lever *h*, which is weighted at *j'*, as said lever is moved by said weight, comes to rest in the position shown in Fig. 4, and the detent *j* is brought into engagement with the hook *k*, thus holding the hair-spring in tension, as before stated. The balance is thus stopped slightly to one side of the center of oscillation and there retained as long as the pin *h'* remains in the notch *g'*. The movement is thus prevented from stopping with the balance-wheel at the dead-point.

The starting mechanism is constructed in the manner to be now described. On the same arbor *b* that carries the notched disk *g* is a small swinging weight or shutter, *d*, that is free to move loosely round the shaft, which has a pin, *d'*, projecting sidewise therefrom. A small carrier or driver, *c*, is rigidly attached to the shaft and has arms *e e'*. These are in the same vertical plane with the drop or weight *d*, and their function is to raise the said weight into its normal position. The momentum of the weight *d* acquired in falling tends to carry the said weight beyond the point at which the pin *h'* is thrown out of the notch *g'*. To prevent this, I allow the arm *e* of the carrier *c* to project downward and form a stop, against which the shutter strikes. The rebound of the shutter is prevented by the notch or shoulder h^2 (shown on lever *h*) and pin *d'* of the weight, as shown in Fig. 5. The weight of the shutter as it passes over the said shoulder in falling slightly depresses the lever *j*; but the lever, being weighted at *j'*, immediately comes back to its former position, and then the shoulder is in position to form a stop, as before described. When the clock is stopped, the weight *d* is, as shown in Figs. 4 and 7, inclined slightly forward of its center of gravity, and is prevented from falling by a hook in the end of a light detaining-lever, R. This is made of a single wire and is pivoted at *f*. The armature N of the starting-magnet M is provided with a metal plate extension, O, prevented from inordinate outward movement by the limit-stop *y*, and provided with a curved end, which touches lightly the short end of the tripping-lever R. The weight or shutter rests lightly against the hooked end of the lever R when the mechanism is in the position shown in Fig. 4. When, therefore, the electro-magnet M is energized and the armature N attracted in the slightest degree the lever R is raised and the weight *d* falls, as shown in Fig. 5. In the fall of the weight *d* the projecting pin *d'* thereof strikes the lower lever, *h*, at a time when its line of motion forms an acute angle with the line of the lever, and, by the momentum given to the weight in falling, the lever so struck is forced downward, withdrawing the pin *h'* from the notch *g'* and releasing the detent, thus allowing the clock to start. The pin *d'* of the weight first falls on the main portion of the long arm of the lever *h*, thus forcing it clear of the disk *g*; but as the arbor *b* rotates the carrier *e* or *e'* advances with it, and upon reaching the weight begins to raise the same, so that the projecting pin *d'* thereof, if its momentum has not already carried it by the shoulder h^2, first slides over the shoulder h^2 and onto the thinner portion h^3 of the lever-arm, and subsequently leaves the said lever-arm altogether, being raised by the carrier *e*, as shown in Fig. 6. This permits the lever *h* to rise; but since the notch *g'* is not opposite or in line with pin *h'* it merely strikes upon the periphery of the disk *g*, and there rides until the return of the notch *g'*, which allows the pin to enter therein. It is thus evident that the work required to start the clock-work is partly conserved by the clock-train itself in raising the weight *d*, which, by its momentum when released, releases in turn the clock-work for another revolution. I thus effect great economy in the strength of current necessary to start the clocks, and am enabled to use a train of any required power to actuate the circuit-changers.

In Fig. 3 I show a spur-wheel, Q, gearing with a pinion, *x*, on the axis of the pointer. A face view of the same wheel is shown in Fig. 3ª. Its front surface is divided into four parts, the two opposite parts, *v*, which are shaded, representing some bright color—such as red—while the other and unshaded portion, V, may be white. When the case A is in place, the hole or aperture T is opposite that one of the division which is at the lowest point, so that sometimes a red and sometimes a white signal appears at the aperture. The wheel Q is so proportioned to the pinion *x* that it makes but one-fourth of a revolution during the time that the said pinion, and of course the pointer P, makes a complete revolution. The wheel Q thus serves as a "line-in-use" signal. When the line is clear, the white surface appears at the aperture T. When the clocks are started to give the signal, the white surface disappears and the clock stops, the signal is supposed to have been given, and telephonic conversation is being carried on. The wheel Q, having meantime accomplished a quarter-revolution, has stopped, showing a red signal, which accordingly indicates that the line is in use. Upon the conclusion of the conversation a "ring-off" signal is given, and the wheel Q, making another quarter-revolution, brings the white surface again to the front, indicating that the line is at liberty.

A third feature of my invention is to provide means to indicate when the clock needs winding. This I accomplish by devices shown in Figs. 2, 9, and 10. A circuit-changer consisting of a spring, *r*, and contact-point *r'*, mounted upon a non-conducting block, r^2, is

affixed to the frame *a* of the instrument, and constitutes a part of the normally-closed shunt-circuit round the bell-magnet G. A star-wheel is fixed upon a stud, *s'*, and has a horizontally-projecting pin, *u*. Upon the axis *t* of the mainspring or motor-drum is another wheel or cam, *t'*, rigidly affixed thereto, and adapted to engage the star-wheel and advance it a short distance each time the said axis revolves. The star-wheel is initially adjusted, so that a short time before the spring or weight runs down the pin *u* will be brought to bear upon the free end of the spring *r*, lifting it from its contact-point *r'*, and thus opening the shunt-circuit. The effect of this is that while the subscriber at this particular station might be called, yet as magnet M, and also the magnet of the signaling device will be in the circuit when the clock is at rest, the current which starts the clock will cause the bell to ring, and for the same reason any signal sent through the station to another station will cause the bell to ring. The subscriber observing that the bell rings when the pointer is not on his particular number or space, knows that the clock is nearly run down and winds it up.

The figures on the dial in Fig. 1 indicate the numbers of the several stations.

I do not confine myself to the particular mechanism described for indicating the necessity of winding, since other means would suggest themselves to a mechanic. I may, for example, use an electro-magnetic alarm actuated by a local circuit, as shown in Fig. 2 in dotted lines, in which H is a vibrating bell; L B, a local battery, one pole of the battery connecting by wire 31 to the frame-work of the instrument, and the other is connected with one of the bell-terminals. The remaining bell-terminal connects by wire 30 with the spring *r*. When, now the, pin *u* of the star-wheel *s* comes into contact with the spring *r*, the local circuit is closed and the bell rings.

I do not claim as my invention a telephone alarm or series of alarms normally shunted from the main circuit, but adapted to be introduced therein through the instrumentality of clock-work electrically controlled from a distant station; nor do I claim apparatus operating a circuit-closer to shunt its own actuating-magnet immediately after it has been set in motion by the said magnet; but

I claim—

1. In an individual signaling apparatus, the combination of a clock-train, stop mechanism therefor comprising a hook or catch on one of the arbors of said train, and a pivoted lever adapted to engage the said catch and thereby stop the said clock-train, so as to hold the balance in tension, and starting mechanism consisting of a swinging weight, a hook-lever supporting the same against gravity over and in line with the stop-lever, an electro-magnet included in the main-line circuit, and an armature-lever operated thereby and adapted to trip the said hook-lever and release the said weight, allowing it to fall on the stop-lever and disengage the same, starting the clock-train, substantially as described.

2. The combination, with a clock-train, of a notched disk fixed to the pointer-arbor and a pivoted lever carrying a pin which is adapted to enter the notch in said disk and the balance-wheel arbor, the lever *j*, and the stop mechanism *k*, whereby the clock is stopped with the said balance in tension, after every revolution of the said arbor, a swinging weight loosely attached to the said pointer-arbor, mechanism actuated by the clock-train for raising the said weight, a tripping-lever for maintaining the weight in position when raised, and an electro-magnet adapted when energized to lift the said lever and permit the said weight to fall upon the stop-lever and disengage the same for the purpose of starting the clock, substantially as described.

3. The combination, in an electrically-controlled clock-train, of a working-arbor driven by said train, a notched disk attached thereto, a hook or catch on the balance-wheel arbor, and a weighted pivoted lever adapted to engage with the said catch, with a shutter or weight loosely attached to and swinging on the said working-arbor, a carrier rigidly attached to said arbor and adapted to lift the said weight, for the purpose of furnishing starting-power, a hooked lever for holding the said weight when elevated in a position gravitating forward, and an electro-magnet controlling said lever and adapted to trip the same, whereby a low degree of magnetic strength is enabled to start a strong and powerful clock-train, substantially as described.

4. A sub-station signaling apparatus comprising the following instrumentalities: an electro-magnetic signal-instrument, a normally-closed circuit shunting the same, two independent circuit-changers included in said circuit, a clock-train adapted to actuate one of the said circuit-changers opening the said closed circuit, and thereby including the signal-instrument in a main circuit connected therewith once each revolution of the center arbor, in order that the individual station-alarm may be given, and to actuate the other circuit-changer, accomplishing the same operation at or immediately before the motor of said clock-train is exhausted, whereby all signals sent on the main circuit are received on the signaling-instrument, thus indicating the necessity of rewinding, an electro-magnet connected to the main line controlling the said clock-train, and a normally-open branch circuit shunting the said electro-magnet and adapted to be closed by the action of said clock-work immediately after the same is set in motion and to be reopened before the said motion is arrested, substantially as described.

5. The combination of a main electric circuit, a branch or derived circuit therefor, and two independent circuit closers or changers, both included in the said branch circuit and

controlling the continuity thereof, one of the said circuit-changers being operated by the center or pointer arbor of a train of clock-work and the other by separate devices actuated by the mainspring or winding-arbor of said clock-train, whereby the derived circuit may be opened and reclosed once in each revolution of the center arbor, and also opened for an indefinite period after one or more revolutions of the winding-arbor, substantially as described.

6. The combination, substantially as hereinbefore described, with a main electric circuit and a signaling-instrument adapted to be included therein, of a branch circuit normally shunting said signaling-instrument, and two independent circuit closers or changers included in and controlling said branch circuit, one of the said circuit-changers being operated by the center or pointer carrying arbor of the clock-train, whereby the shunt-circuit is opened at a definite time once in each revolution of said arbor, and the signaling-instrument thus introduced into the main circuit for the purpose of individually sounding an alarm thereon, the other circuit-changer being operated directly by the mainspring-arbor of the said clock-work after a certain number of revolutions thereof, to break the shunt-circuit, for the purpose of introducing the signaling-instrument into the main circuit when the motor of said clock-train is completely or nearly run down, so that all signals may be thereupon sounded on the said signaling-instrument.

7. The combination, in an electric signaling system, of a main circuit and electric bell-alarm included therein, a normally-closed shunt-circuit around the magnet of said bell, two circuit-closers included in said shunt-circuit, a clock-train and starting-magnet therefor adapted to operate one of said circuit-changers, opening the shunt-circuit thereat when a signal is to be received and closing the same immediately thereafter, and mechanism for operating the second circuit-closer, opening the said shunt-circuit and holding the same open when the clock-motor has run down, substantially as described.

8. The combination, substantially as hereinbefore described, of one or more circuit closers or changers, a clock-train actuating the same, a stop mechanism therefor adapted to stop the said train with its balance-wheel in tension, a starting device comprising a weight raised by the clock-work itself during one revolution, and adapted by its fall to disengage the said stop mechanism, and an electro-magnet armature and hook-lever controlled thereby, arranged to maintain the said weight normally in position, but to release the same, permitting it to fall for the purpose of starting the clock when the electro-magnet is energized, for the purpose specified.

9. The combination, in a train of clock-work, of the disk *g*, fixed to the driven arbor, and having the notch *g'*, the catch *k*, fixed on the balance-shaft, the drop-weight *d*, adapted to be raised by the power of the clock-train to a forwardly gravitating position, and provided with the pin *d'*, the hook-detaining lever therefor, and an electro-magnet controlling the same, and the pivoted stop-lever *h*, adapted to engage the catch *k* and to be released therefrom when struck by the pin *d'* of the falling weight, the said lever *h* being also provided with a projecting pin, *h'*, adapted to ride upon the periphery of the notched disk until the notch arrives opposite thereto for the purpose of maintaining the disengagement of the catch *k*, substantially as described.

10. The combination, substantially as hereinbefore described, of the lever *h*, the notched disk *g*, the pin *h'*, adapted to enter the notch in said disk, the weight *d*, and pin *d'*, attached thereto, whereby the weight when fallen is adapted to disengage the lever and disk and to maintain the said disengagement, and the carrier or driver *e e'*, for lifting the said weight, all co-operating as and for the purposes specified.

11. The combination, with an electrical signal apparatus and a clock-train controlling the same, the said clock being normally at rest and provided with a pointer fixed upon its working-arbor, and also adapted when started, to stop after a single revolution of said pointer, of a visual signal consisting of a disk having a toothed edge gearing with a pinion on the pointer-arbor, and adapted to rotate at a speed having a definite ratio to the speed of said pointer-arbor, the said disk having its face divided and a part thereof specially colored, and being arranged to show the colored portion only during the time that the line is being used, substantially as described.

12. The combination, with a clock-spring, of a weight which is raised by the force of said spring, a lever which normally holds said weight from falling, an electro-magnet in an electric circuit, and its armature for tripping said lever, so as to release the weight when the electro-magnet is energized, a lever or detent which normally holds the train and which is moved by the force of the falling weight, thereby releasing the clock-train and allowing the said clock-train to be started, actuated by the force of the spring, as described.

13. The clock-train normally held by the pivoted detent or lever which engages with a hook or catch upon the balance-wheel arbor, a weight moving freely around the working-arbor, a carrier for lifting said weight attached to and moving with the arbor, the lever by which the weight is held when raised by the carrier, an electro-magnet in an electric circuit which when energized operates to trip the said lever and release the weight, which, falling upon the pivoted detent, disengages the same from the catch upon the balance-staff, whereby a portion of the force of the

mainspring is stored and used to release the clock-train, substantially as described.

14. The combination, with the weight, of the carrier provided with the wire or arm *e'*, which comes under the weight and lifts the same, and the wire or arm *e*, extending in the opposite direction, which serves as a stop for said weight and prevents the same from swinging inordinately, and the shoulder upon the lever *h*, against which the weight rebounds, as and for the purpose specified.

In witness whereof I hereunto subscribe my name this 10th day of March, A. D. 1885.

ERNEST P. WARNER.

Witnesses:
G. W. WILCOX,
F. H. MCCULLOCH.