(No Model.)

W. J. DUDLEY.

ELECTRIC SIGNALING APPARATUS.

No. 342,340. Patented May 25, 1886.

Fig. 1.

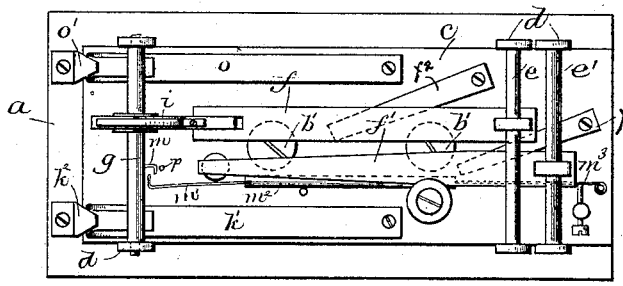


Fig. 3.

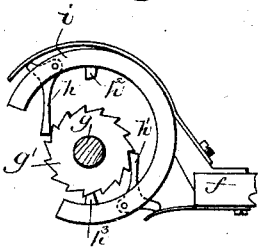
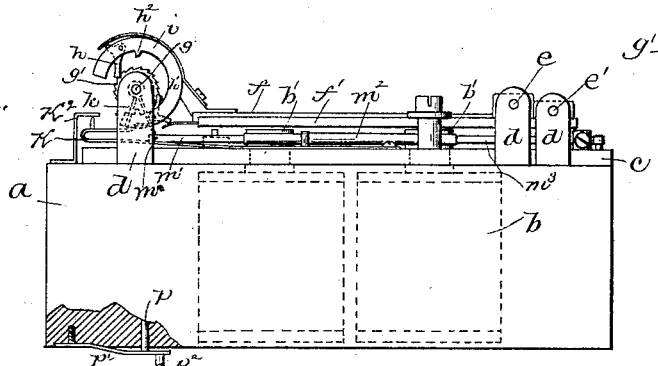


Fig. 2.



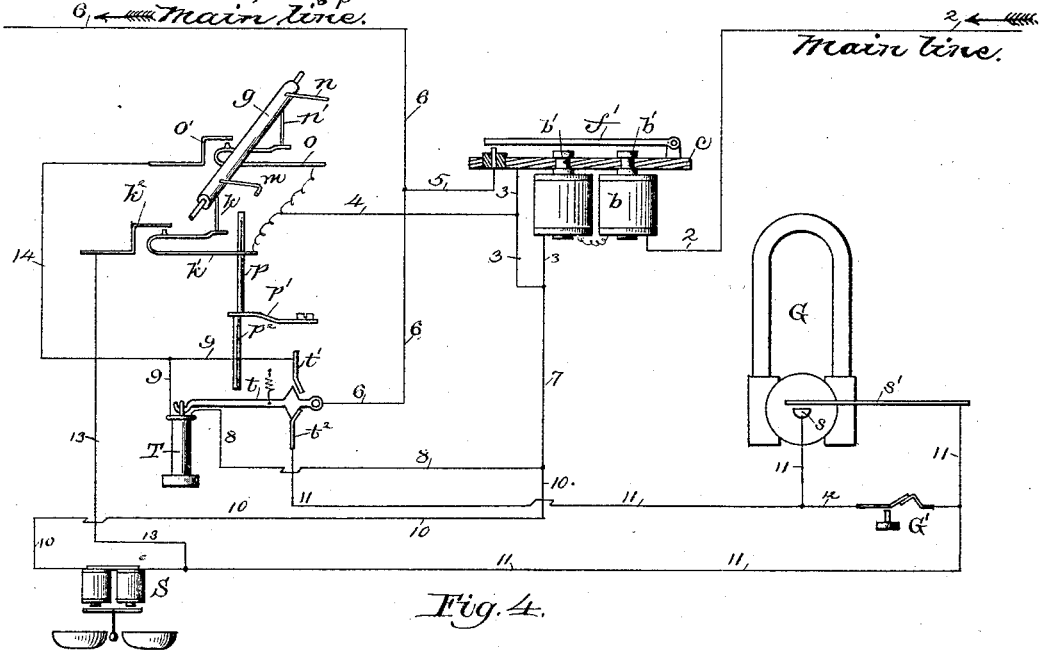


Fig. 4.

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UNITED STATES PATENT OFFICE.

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ELECTRIC SIGNALING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 342,340, dated May 25, 1886.

Application filed April 27, 1885. Serial No. 163,556. (No model.)

To all whom it may concern:

Be it known that I, WALTER J. DUDLEY, residing in Everett, Middlesex county, State of Massachusetts, have invented an Improvement in Electric Signaling Apparatus, of which the following description, in connection with the accompanying drawings, is a specification, like letters on the drawings representing like parts.

My invention relates to an electric signaling apparatus, such as used on telephone-circuits, and commonly known as an "individual" signaling apparatus, there being a number of signaling-instruments at different points or stations in one circuit, properly constructed to enable any desired one of said signals to be operated without the others.

My invention is embodied in a signal-controlling instrument comprising an electro-magnet in the main circuit having neutral or soft-iron cores acting on different armatures, one of which may be called the "actuating-armature," and has a vibratory movement toward and from the poles of the magnet, in which movement it actuates a step-by-step device, and after one particular step or at one definite position arrived at after a movement produced by a definite number of to-and-fro movements of the armature, after the step-by-step device starts from a given point, called the "unison-point," the said step-by-step device places the signal controlled by the said instrument in condition to be operated by a current of proper character. Each of the signal-controlling devices at the different stations places the signal controlled by it in condition to be operated after a different number of movements from the common starting-point, so that only one signal is in condition to be operated at the end of any given number of movements, and each signal may be operated, as desired, by producing the proper number of movements for that particular signal, as is usual in individual signal apparatus containing step-by-step devices. The step-by-step devices actuated by the vibrations of the neutral armatures in the different instruments, as just described, are each provided with one member of a stopping device, which at a given point in the step-by-step movement is engaged by the co-operating member of the said stopping device, that is connected with another neutral armature, herein called the "unisoning-armature," operated by the same electro-magnet as the vibrating or step-by-step armature, and being so proportioned in size and provided with a retractor of such strength that at the first attractive impulse by which the step-by-step armature is actuated the said unisoning-armature will be attracted to the poles of the magnet, and will remain held there by the residual magnetism during the subsequent variations in magnetic condition by which the step-by-step armature is actuated. When, however, short impulses of alternating polarity—such as produced by magneto-electric machines—are caused to act on said magnet, their effect is to neutralize or destroy the residual magnetism, thus releasing the unisoning-armature, and permitting it to disengage the stopping device, which has held the step-by-step device, releasing the latter at the proper starting-point corresponding with the other instruments, all of which have been engaged by their corresponding stopping devices, and released simultaneously in proper relation or in unison with one another. The step-by-step device, as shown in this instance, places the corresponding signal in operative condition at one particular step in its movement by opening a normally-closed shunt around the said signaling-instrument, which is of the proper character to be operated by short impulses of reversed polarity, such as commonly produced by magneto-electric generators, and which do not affect the step-by-step actuating-armature in passing through the coils of its magnet. The step-by-step device is also made to control the telephone or other instrument at the said station, enabling the telephone to be placed in circuit only when the signal at the same station is in circuit, or when the signaling devices are at the unison-point. Thus, when the signal at any station is operated, the telephone at that station only on the line can be placed in circuit, thus maintaining secrecy, so far as the other stations of the said circuit are concerned. The step-by-step device is also controlled by the telephone-supporting switch, which, when the weight of the telephone is removed therefrom, mechanically operates a stopping device for the step by step device, arresting it at the unison-point, and thus placing the telephone,

which has been removed from its hook previous to the operation of the signaling device, in circuit, so that a subscriber who wishes to be placed in communication with another on the same line will, by removing his telephone from the hook to communicate with the operator at the central office, cause the said telephone to be placed in circuit, when the operator at the central office causes the signal-controlling devices to be brought to the unison-point, and the said telephone will be retained in circuit by the mechanical device or stop, while the central-office operator calls the other station, in which latter operation the telephones at all other stations will be cut out of circuit. The magnet of the signal-controlling instrument is also provided with an armature which short-circuits the telephone and other apparatus at the station in case it should accidentally be left in circuit, so that the said telephone or apparatus will not by its resistance so weaken the current as to cause the step-by-step actuating-armature to fail to operate. The said short-circuiting armature itself has a comparatively weak retractor, so that it will be operated even if the telephone should be in circuit and it accompanies the step-by-step actuating armature in its to-and-fro movements, or moves up slightly in advance thereof, in case the resistance is in circuit, in which case the actuating-armature will follow each movement of the short-circuiting armature after the resistance has been removed by the latter.

Besides the general combination and arrangement of the signal and telephone controlling devices, the invention further consists in details of construction, the objects of which are to render the step-by-step device extremely certain in operation and to simplify and reduce the expense of the instruments.

Figure 1 is a plan view of a signal-controlling instrument embodying this invention; Fig. 2, a front elevation thereof; Fig. 3, an enlarged detail of the step-by-step actuating device, and Fig. 4 a diagram showing the circuit-connections of the signal-controlling instruments with the other apparatus at a station.

The signal controlling instrument is shown as supported on a block, *a*, which may be of wood bored to receive the actuating-magnet *b*, (shown in dotted lines, Fig. 2,) the poles *b'* of which project up through a plate, *c*, provided with bearings *d*, for shafts or pivots *e e'* for one end of the armatures *f f'* of the said electro-magnet *b*, and for the shaft *g* of the step-by-step device, comprising a ratchet, *g'*, on the said shaft and actuating-pawls *h h'* therefor, connected with a frame, *i*, fixed upon the armature *f* of the magnet *b*, as best shown in Fig. 3. The block or frame-piece *a* may be supported on the box containing a magneto-generator, G, (see Fig. 4,) signal S, and switch *t*, for supporting the telephone T, all of which may be of usual construction, and are only indicated in the diagram, Fig. 4. When a series of electrical impulses of proper strength and duration, which will be called "actuating-impulses" or "currents," are imparted to the circuit of the magnet *b*—such, for instance, as produced by alternately breaking and closing the circuit while a battery is included therein—the armature *f* will be vibrated to and fro, and at each to-and-fro movement will advance the ratchet *g'* for the space of one tooth, and the movement of the said ratchet will thus correspond to the number of such impulses applied to the magnet *b*. The retractors for the armatures *f f'* are shown in Fig. 1 as flat springs f^2 f^2, which have one end fastened upon the plate *c*, and the other end bearing with spring-pressure against the under side of the corresponding armatures. The shaft *g* of the said ratchet which thus receives the step-by-step rotary movement is provided with an arm or projection, *k*, (best shown in Fig. 4, where the said shaft is shown in perspective,) and the said arm *k* at one step in the movement of the shaft acts upon one member, *k'*, of a circuit-controlling device, separating it from the other member, k^2, thereof, and thus opening the circuit between the said members at this particular step in the movement of the shaft, although the said members are connected and the circuit closed between them when the shaft *g* is in any other position. The members *k' k²* are in a shunt or branch of low resistance around the signal-instrument S, and normally when in contact divert the current from said instrument, which can thus be affected only when the shaft *g* is in the particular position shown in Fig. 4, at which time the said members *k' k²* are separated and the signal S^2 in circuit.

It will be understood that the shaft *g* of the instruments at different stations on the same line are all moved simultaneously by the vibrations of the armatures *f* of the said instruments, and that the arms *k* of the different instruments are at different positions with relation to the member *k'* of the circuit-controlling device, so that only one of the said members will be engaged by the arm *k* in any one step in the simultaneous movement of the shafts *g*, and that the said members *k'* at the different stations will be engaged one after the other in the said movement, so that it is necessary, in order to call any given station, that the shafts *g* should all be rotated far enough for the one to engage the member *k'* at that particular station when the signal S at that station, and at no other, will be in circuit, after which the said signal may be operated by currents of such character as will not appreciably affect the armatures *f* of the different instruments, the signal S being, for instance, operated by the short impulses of alternating polarity that are generated by the magneto-electric generators commonly employed in telephone-signals.

In order that the shafts *g* of the instruments at the different stations may always be in proper position with relation to one another,

or may be brought into such position in case any one has gained or lost a step with relation to the others, means are provided for bringing the said shafts or step-by-step devices into unison with one another, before being operated to produce a signal. In order to effect the unisoning of the said shafts, they are each provided with one member, *m*, of a stopping device (shown as consisting of an arm provided with a short laterally-projecting finger) which in the rotary movement of the said shaft is engaged by the co operating member *m'* of the stopping or unisoning device, the said member *m'* being carried by an armature, m^2, (shown as placed at the sides of the poles *b'* of the magnet *b*,) and connected with or supported on a spring, m^3, which tends to retract the said armature or move it away from the poles of the magnet, in which retracted position the stop member *m'* is also removed from the shaft *g*. The armature m^2 is of soft iron, and comparatively small, and when the magnet *b* is affected by the impulses which actuate the armature *f* the armature m^2 will also be attracted, and its retractive force is insufficient to overcome the residual magnetism and withdraw it from the poles of the magnet *b* during the short intervals which occur between the successive attractive impulses that affect the armature *f*. When, however, currents of rapidly-alternating polarity—such as operate the signal S—act on the magnet *b*, they immediately neutralize or destroy the residual magnetism, permitting the armature m^2 to be retracted, and thus release the shaft *g*. The currents for actuating the armatures *f* and m^2 and the signal S are preferably applied by an automatic transmitting-instrument invented by me, forming the subject of another application for Letters Patent. The said transmitting apparatus, or, if such be not employed, the operator, by manipulating a suitable key, will first cause a number of impulses of proper character to affect the armature *f* to pass through the magnet *b*, sufficient to turn the shaft *g* at least a full revolution and one or two steps beyond, so that any shafts which may have lost a step will have an opportunity to gain it, the armature m^2 being held up to the poles of the magnet during and between these impulses, and the stop members *m'* thus being caused to engage the stop members *m* of the different shafts as they arrive at the said members *m'*, thus arresting the shafts in the same position with relation to the stop members *m'*, and with their signal controlling arms *k* distributed in different positions with relation to said stop members and to the members *k'* of the circuit-controlling devices, so as to act successively on the latter in the further movement beyond the stopping or unisoning point. A few alternating impulses are then applied to the magnet *b*, which cause the release of the armature m^2 and the shafts *g* without affecting the armature *f* or moving said shafts, except for a very small fraction of a turn, produced by the further retractive movement of the armature *f*, which was not quite complete when the stop member *m* was engaged, and is sufficient to carry the latter beyond the member *m'*, so that it will not again be engaged when the actuating impulses begin. The shafts are thus all released in unison with one another, and the operator or transmitter, by applying the proper number of additional impulses, will cause the shafts *g* to turn far enough to engage the member *k'* at the station that is to be signaled, the arms *k* at the other stations either having passed beyond or not yet reached the corresponding members, *k'*, which consequently will remain in their normal position in contact with the members k^2. The operator or transmitter then causes a series of alternating currents to pass over the line, which operate the signal S at the station where the circuit-controlling device *k' k²* is opened, but produce no other effect, thus calling the desired station, and that one only. The shafts *g* are shown as also provided with telephone-controlling devices or arms *n n'*, cooperating with a circuit-controlling device, *o o'*, similar in construction to the one *k' k²*, and forming a part of a shunt or circuit of low resistance around the telephone T, which shunt is closed, preventing the telephone from being placed in circuit at any given station, except when the signaling devices are at the unison-point, when the arms *n*, which correspond in position to the stop members *m*, will engage the members *o* at all the stations, and when the arm *k* is in position to place the signal S at a given station in circuit the arm *n'*, which corresponds in position to the one *k*, will place the telephone in circuit or in condition to be circuited by its own switch at that particular station, but at no other. Thus persons at stations which have not been called or signaled cannot place themselves in circuit and overhear the conversation carried on by the person at the station where the signal was operated.

When a subscriber desires to call the central office or produce a signal at another station than his own, a generator, G, (see Fig. 4,) is employed, being of usual construction, except that its commutator *s s'* is constructed to transmit only the intermediate impulses of like polarity, so that they will not affect the signals S of the station on the said circuit that has last been called, and at which the circuit-controlling device *k' k²* is left open by the step-by-step signal controlling mechanism.

When a subscriber wishes to be placed in communication with another on the same circuit, it is necessary to provide means for placing the telephones at both stations in circuit without permitting the telephone to be placed in circuit at any other station. To accomplish this the instrument is provided with a stop member, *p*, consisting, in this instance, of a pin resting on a spring, *p'*, adapted to be engaged and lifted by a rod, p^2, operated by the telephone-supporting switch *t*. The rod is raised when the telephone is removed from

the hook, as is done when the subscriber signals the central office, the telephone being then placed in circuit by the operator at the central office, actuating the step-by-step devices so as to bring them to the unison-point, at which point the stopping device *p* at the station where the telephone has been removed from the hook engages the stop member *m* of the step by-step device, preventing further rotation thereof, and thus retaining the step-by-step device of that particular instrument at the unison point and the telephone T in circuit at that station, while the step-by-step devices at the other stations are moved by the operator at the central office in order to call the other station, thus placing the telephone at the station called in circuit by the arm *n'* of the step-by-step device while the telephones at all the other stations are shunted by the circuit-closers *o o'*.

As the resistance of the telephonic instruments is quite large, it might interfere with the working of the armatures *f* if it were in circuit while the signaling-instruments were being operated. In order to prevent such interference with the operation of the signaling-instruments, the latter are provided with cut-out armatures *f'*, operated by the magnet *b*, but independent of the armatures *f* and m^2 of the step by-step and unisoning devices. The said armatures *f'*, when attracted, close a shunt around the entire apparatus at the station, except the magnet *b*, and as the said armatures *f'* have no mechanical work to do their retracting-springs f^2 f^2 are comparatively weak, so that they will be attracted, even if the resistance of the telephonic instruments should be in circuit, and as soon as they are attracted they will remove the resistance, so that the armature *f* is immediately attracted, and thus properly operates the signals.

The mechanism for producing the step-by-step movement (best shown in Fig. 3) consists of a frame, *i*, extending at opposite sides of, or rather more than half way around, the ratchet-wheel *g'*, or it might wholly encircle the said wheel *g'*, this frame having pivoted on it spring-pressed pawls *h h'*, which engage the ratchet-wheel at opposite sides, thus turning the latter preferably for the space of one-half a tooth at each movement of the armature *f* in each direction. The said frame is also provided with stop projections h^2 h^3, which strike upon the wheel at the end of the movement of the frame in either direction, thus limiting the said movement, and at the same time positively locking the wheel, so that it cannot turn beyond the point to which it is positively moved by the pawl last acting on it. This mechanism is very simple, and at the same time very positive and certain in operation, moving the wheel for the space of one tooth at each complete forward and backward movement of the armature, and being capable of operating at very high speed without skipping a movement, and also without overthrowing or moving the wheels farther than they should be moved by a given number of vibrations of the lever.

The circuit may be readily traced in Fig. 4. The main line entering the station at one side is connected, as shown at 2, with one terminal of the magnet *b*, the other terminal of which is connected by wire 3 with the plate *c* of the signaling-instrument, which is also electrically connected with the springs *k'* and *o*, as indicated by the wire 4 in Fig. 4, and with the armature *f'*. The contact-point engaged by the said armature when attracted is connected by wire 5 with the main line 6, leading from the station, so that when the said armature is attracted the magnet *b* only will be in circuit, the branch 3 5 constituting a shunt for the remaining apparatus. From the wire 3 the main line is continued by wire 7 and wire 8, branching therefrom, to one terminal of the telephone T, the other terminal of which is connected by wire 9 with the spring *t'*, that is connected with the telephone-supporting hook or switch when the telephone is removed; but when the telephone is on its hook the branch 8 9 is open at *t t'*, as usual. The branch 10 from wire 7 passes to one terminal of the signal S, the other terminal of which is connected by wire 11, including the generator G, having the usual shunt-circuit, 12, containing a normally closed switch, G', and is connected with the contact-spring t^2 of the telephone-switch *t*, which latter is connected with the main line 6, leading from the station. The member k^2 of the circuit-closer, which controls the signal, is connected by wire 13 with the branch wire 11, so that when the said circuit-closer is closed and the telephone on its hook the currents will pass over the circuit 2, 3, 4, *k'*, k^2, 13, 11, (including the generator G or its shunt 12,) t^2, *t*, and 6, without affecting the signal S; but when the members *k' k²* are separated and the telephone T on its hook the currents will pass over the circuit 2, 3, 7, 10, 11, t^2, *t*, 6, including the signal S, the branch 8 then being open at *t'*, the branch 4 at *k' k²*, and also at *o o'* or at *t t'*. The member *o'* of the circuit-closer *o o'* is connected by wire 14 with wire 9, so that if the said circuit-closer is closed and the telephone off its hook the current will follow the circuit 2, 3, 4, *o*, *o'*, 14, 9, *t'*, *t*, 6 without affecting the telephone T; but if the said circuit-closer *o o'* is open the current will follow the circuit 2, 3, 7, 8, T, 9, *t'*, *t*, 6, including the telephone, the branch 4 then being open at *k' k²* and *o o'*, and the branch 10 11 being at t^2, as would also be the branch 4 13, if the circuit-closer *k' k²* were closed. The armature *f'* is retracted and the shunt 3 5 open whenever the signal S or the telephone T is operated, it being closed only during the impulses that actuate the armature *f*.

I claim—

1. A signal-controlling instrument comprising a neutral electro-magnet and actuating-armature and retractor therefor, a step-by-step device actuated by the said armature,

governing the operation of the signaling-instrument, a stop member connected with the said step-by-step device and a co-operating stop member and neutral armature connected therewith, and the retractor for the latter armature adjusted to cause the said armature to be attracted by the impulses that move the actuating-armature, and to be held by residual magnetism between said impulses in position to engage the stop members, and to be retracted when the magnet is affected by currents of alternating polarity into position to disengage the stop members, substantially as described.

2. The combination of a step-by-step device and neutral electro-magnet and actuating-armature and retractor therefor with a stop member carried by the said step-by-step device, a co-operating stop member and controlling-armature therefor, held by residual magnetism in position to engage the other member and arrest the step-by-step device at the unison-point while the actuating-armature is being operated, a signaling-instrument operated by currents of alternating polarity and shunt therefor, a circuit-controlling device in said shunt operated by the step-by-step device to open the said shunt at one step in its movement, a telephone and shunt-circuit therefor, and a circuit-controlling device in said shunt-circuit operated by the step-by-step device, being opened when the said device is arrested at the unison-point, and also when the shunt of the signaling-instrument is opened, substantially as described.

3. The combination of the step-by-step device and electro-magnet and actuating-armature and retractor therefor with telephonic instruments connected with the circuit of the said magnet and a shunt for said instruments, and armature operated by said magnet controlling the said shunt, which is closed by the said armature at each impulse that operates the step-by-step actuating-armature, substantially as described.

4. A step-by-step device provided with a stop member and with devices controlling the circuit of a telephone and signaling instrument, combined with the telephone-supporting switch and a stop member controlled thereby, being placed by the said supporting-switch when the telephone is removed therefrom in position to engage the stop member of the step-by-step device and arrest the said device in position to place the telephone in circuit, substantially as described.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WALTER J. DUDLEY.

Witnesses:
JOS. P. LIVERMORE,
H. P. BATES.